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مجلة جمعية المهندسين المصرية

المجلد الثالث عشر — العدد الأول (يناير ـ فبراير ـ مارس) ١٩٧٤

- تصدر المجلة ربع سنوية
- ترسل النصوص المطلوب موافقة هيئة التحرير على نشرها باسم السيد / رئيس التحرير . وهو غير مسئول عن فقد أو تلف أى نص .
- تنشر المجلة المقالات التى تسهم فى رفع مستوى العلوم الهندسية وطرق ممارستها
- تقبل للنشر المقالات باحدى اللغتين العربية أو الانجليزية ، على أن تقدم من ثلاث نسخ مكتوبة على الآلة الكاتبة ومعها ملخص بكل من اللغتين .
- تذكر أسماء أصحاب المقالة كاملة باللغتين ومعها القابهم العلمية ووظائفهم .
- يراعى ألا تتجاوز المقالة ٨ صفحات بالمجلة ، وفى سبيل ذلك يختصر الاشتقاق الرياضى ويستعاض عن الجداول بمنحنيات مرسومة بالحبر الشينى الأسود ، على أن يشغل المنحنى نصف صفحة على الأكثر ولا يشغل صفحة كاملة الا فى حالات استثنائية وسيصغر أى منحن الى تلك المقاسات .

ويراعى الا يقل ارتفاع الحروف أو الأرقام على المنحنيات المنشورة عن ٣ مم بعد التصغير .

- يعنى بذكر المراجع المستقى منها المقال وتصنف تبعا لاسم المؤلف ثم العنوان ثم المجلة أو الكتاب وتاريخه .
- تقدم لصاحب المقال تجربتان للطباعة وترفق بالأولى نسخة من مصطلحات التصحيح التى يؤدى اتباعها الى رفع كفاية التصحيح وتقليل الوقت الضائع فيه .

الاشتراكات :

* يتلقى أعضاء الجمعيات التخصصية نسخهم مجانا
* ولغير الأعضاء :

	قرشا
قيمة الاشتراك السنوى للمهندسين	١٠٠
الاشتراك لغير المهندسين فى السنة	٣٠٠
الاشتراك للهيئات	٥٠٠

الاعلانات :

مؤسسة مصر للطباعة والنشر

القاهرة ١٩ شارع سوق التوفيقية ت ٧٢١٩٢

محتويات العدد :

التشييد والبناء

القسم العربى :

النشاط الجارى :

القسم الأفرنجى :

التصنيع والانتاج

القسم العربى :

النشاط الجارى :

القسم الأفرنجى :

الخامات الأولية والصناعات الكيمائية

القسم العربى :

النشاط الجارى :

القسم الأفرنجى :

التشـــييد والبنـاء

جمعية المهندسين المدنيين
جمعية المهندسين المعماريين
جمعية مهندسى الرى

column. Thereby the core is relieved of the loads, but, first of all, the horizontal deflections are reduced (as if the top of the building was pushed back by the positive bending moments).

In systems stiffened with internal core and with external shear walls (eventually an external core) the internal core is, in this case; the more relieved than in preceding cases. The horizontal load is assigned to the two cores in proportion to their stiffness in horizontal direction.

3. BEHAVIOUR UNDER NON-UNIFORMLY DISTRIBUTED LIVE-LOAD:

In certain systems (e.g. in systems B, C and D) a non-hniformly distributed liveload acting on the floors may produce bending moments in the core. What loading assumptions will be taken as basis of the calculation; depends on the result of a preliminary analysis of the probable load distribution and on the judgement of the structural engineer responsible for the design. So for example, the assumption that one half of the plan area will carry 100% and the second 50% of the live load or 50% and 0 % gives probably a limit value which should be considered for the calculation.

4. DIFFERENTIAL LINEAR DEFORMATIONS :

While designing the discussed systems it is necessary to take account of the effects of differential deformation (contraction, elongation) of both internal and external vertical structures. These differences may be due to various causes such as:

1. differences of elastic and plastic deformation due to normal forces acting on cross-sections.
2. differential temperature changes.
3. shrinkage and creep in reinforced concrete cores.

These effects must be considered during the design and the additional stresses must be taken into account. The unfavourable consequences may be reduced by structural modifications or by suitable procedure of construction work.

5. SEISMIC EFFECTS :

In our area the seismic effects are, as a rule, lower than the wind effects and do not find application in the design. If it is considered that in seismic areas it is desirable to design structures with as long a period of natural vibration as possible "softer systems", than from the point of seismic effects it would be more suitable to use systems in which the core is the only structure resisting horizontal loads like in the case of suspended structures.

G. NASSAR



pared systems. In Fig. 5 the diagrams of moments and normal forces as well as the deformation of the core are shown. In reinforced concrete structures it is important to know for the design of the tension reinforcement due to bending, the value of the compression load which acts simultaneously on the core. In this case it is more favourable if the largest possible share of the vertical load is carried by the core, whereby a compression prestress is provided as a reserve for counteracting the tension stresses due to bending moments.

In systems A, B, C, D the core is the only structure carrying horizontal loads. For reinforced concrete cores the systems B, C will be more convenient from the point of view of smaller tension stresses, because in these systems the compression load in the core is larger.

In the combined system E the peripheral columns are recruited to resist the bending moments, too. When designing the grid hat which might behave like a rigid slab all over the plan it is possible to provide for all the columns being in action for any direction of the horizontal load. The peripheral columns will take up a certain part of the moment which is constant all over the height of the

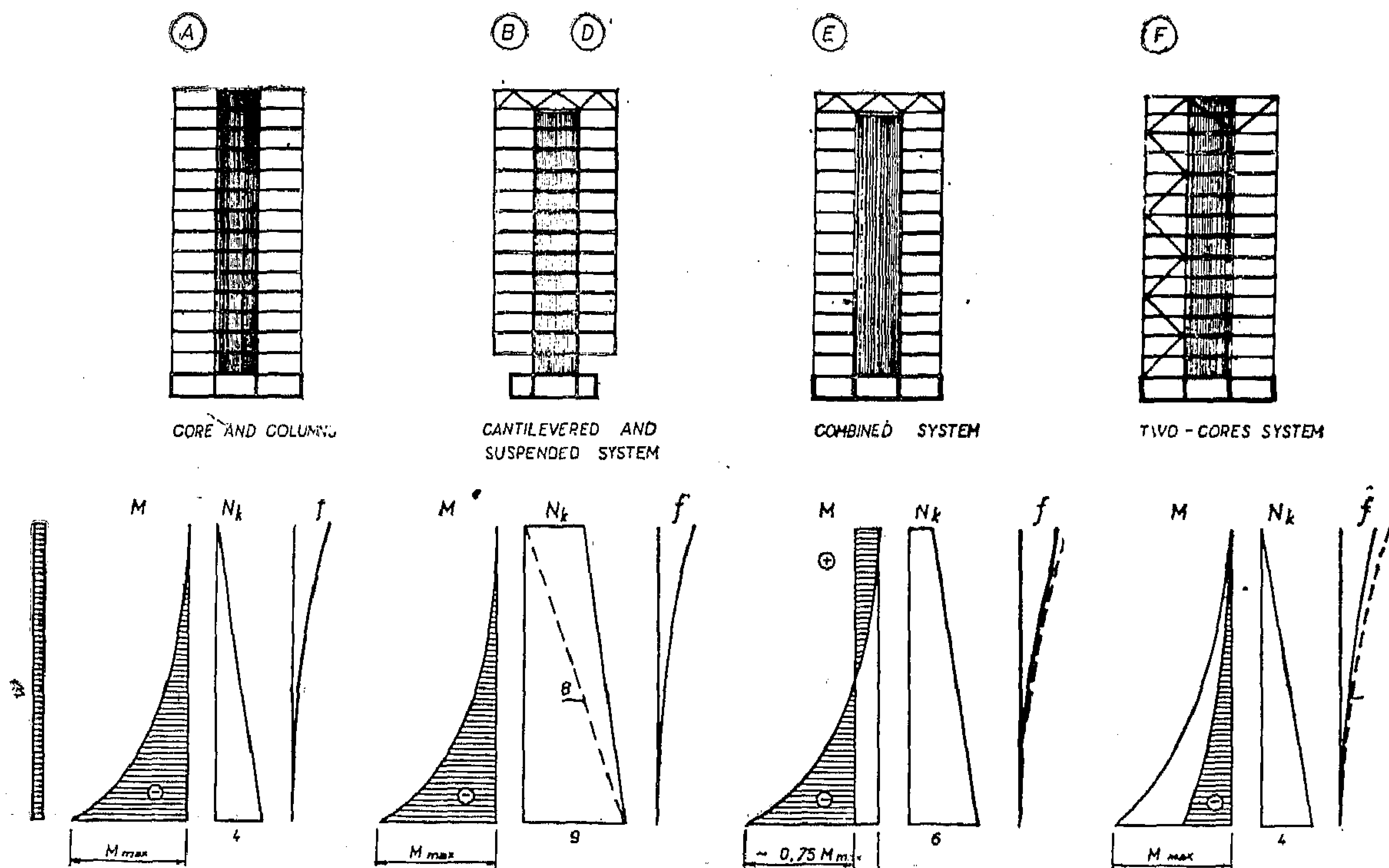


Fig. 5 : Horizontal load distribution on carrying structures

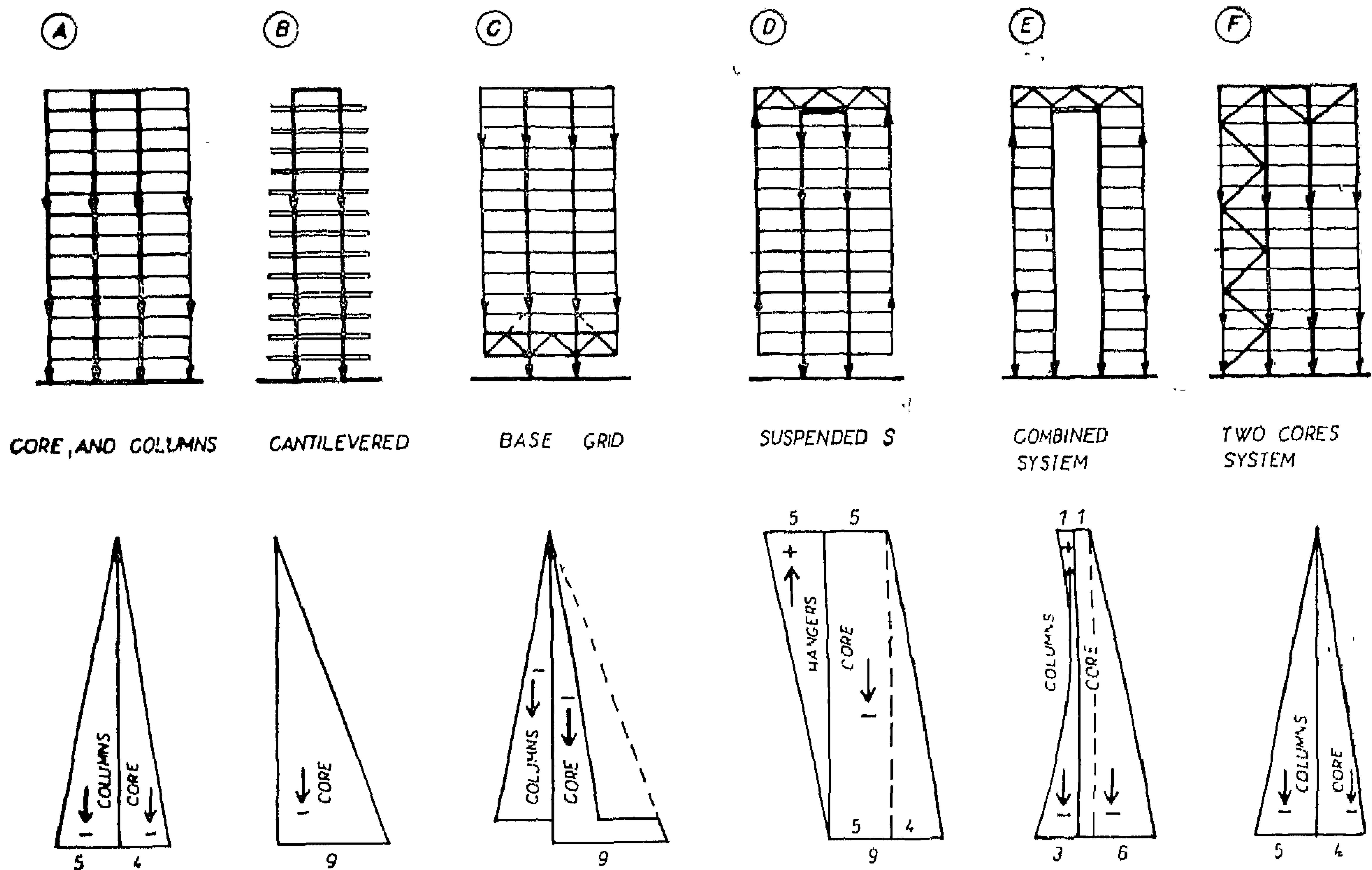


Fig. 3 : Vertical load distribution on carrying structures.

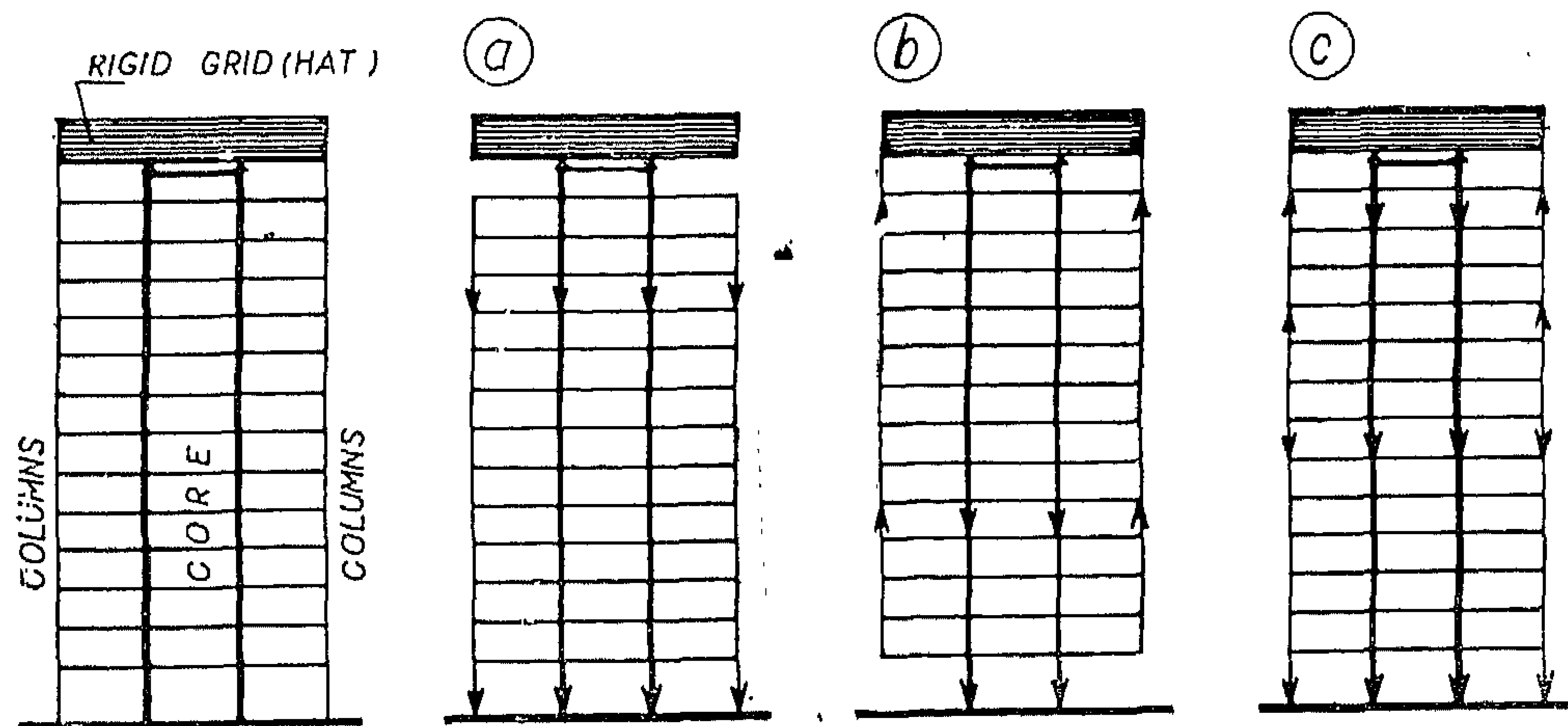


Fig. 4 : Combined systems

this system are less loaded than in system A because one part of the vertical load is transmitted by tension and taken up by the upper grid which will transmit it by compression to the core.

2. BEHAVIOUR UNDER HORIZONTAL LOADS:

Assuming equal windward surface the resulting external bending moment due to wind on the building as a whole is the same for all the com-

Each of the shown systems has its advantages as well as limits for use. These limits may be the function of the building and thereby the requirements on its layout, architectural aspects, the overall height of the building, statical and structural reasons, points of view or production and assembly and particularly the economic criteria which must be taken into account when the choice of the system is made.

The characteristic features of statical systems may best be elucidated by comparing their behaviour under different loads. For the purpose of the comparison a simplified loading condition is adopted. A tall building with square shape in plan 3 a x 5 a and with a central core a x a and with columns in the peripheral (Fig. 2) is considered.

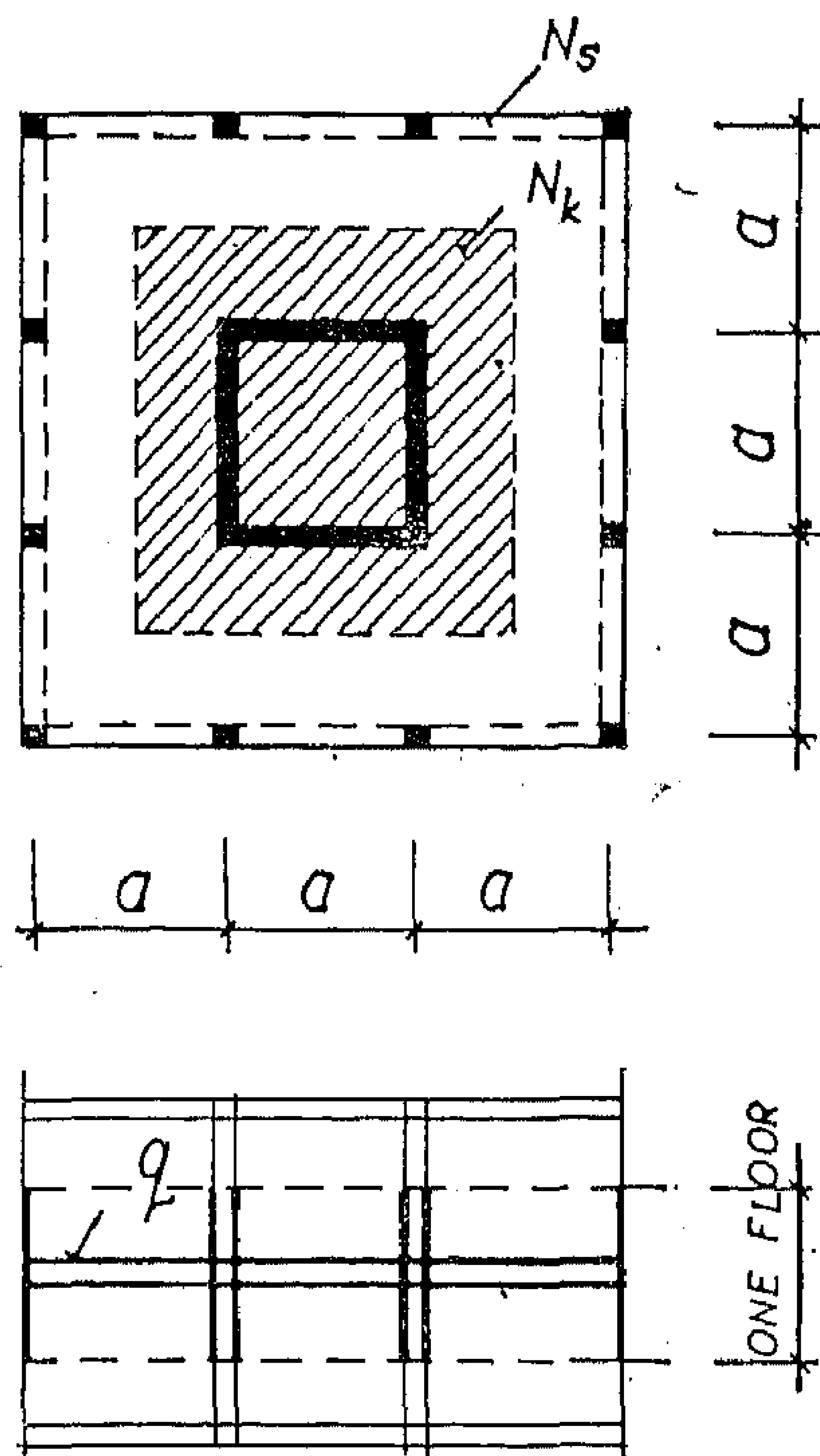


Fig. 2 : Scheme of a floor of the compared Structure.

1. BEHAVIOUR UNDER VERTICAL LOADS :

An average uniformly distributed load g was assumed.

In this load all dead and live loads ried by the core and by the columns on the outer perimeter can be calculated:

Total load = 9 a^2q

Load on Core = 4 a^2q

Load on Columns = 5 a^2q

The relations derived for one floor apply to the whole building. Because the a2q values and the number of floors are assumed to be equal for all the compared variants, the figures express the relative values of the loads. In tall buildings, it is justified to adopt a simplified assumption that the variation of normal forces in the vertical structures is linear. An idea on the distribution of loads to vertical struutures may be acquired on the basis of a schematic representation of totals of normal forces (Fig. 3).

The vertical load is channelled into the columns and the core in the shown proportions.

In the combined system E, the distribution of the vertical load depends on the rigidity of the acting members.

This combined system becomes effective like in the case of composite steel and concrete beams only after the assembly. During the construction the statical system may be modified (Fig. 4). So for example, so long as the hangers are not connected with the top grid (Fig. 4a) the structure behave like a column system. Inversely, should the structure be assembled from top to the base (Fig. 4b) it would behave like a suspended system.

By choosing a convenient construction procedure the load may be conveniently distributed to columns and the core. In principle, the columns in

ON THE BEHAVIOUR OF TALL BUILDINGS WITH CORES

After reviewing the different points of view in the analysis and design of tall buildings with special reference to office buildings Dr. Jiri Kozak and other from Bratslava (Czechoslovakia) discussed the overall statical concept of cored buildings.

On these pages a trial is made to reproduce the main ideas which were introduced in this subject during the Bratislava Regional Conference on the Planning and Design of Tall Buildings.

The solution making use of the internal core is suitable especially for office buildings allowing to concentrate in the middle of the buildings all vertical transport, wiring and piping, accessoreis etc. The walls of the core may be massive, weakened by holes, framed, latticed etc. but in spite of this they are no obstacle to the solution of the plan and they allow to keep space beyond the core free without bulky vertical columns.

The advantage of cores is that they, as spatial structures, are capable of resisting all types of loads: axil loads, shear-forces and bending moments in all directions as well as torsional moments due to horizontal forces passing beyond the sheer center. The position of the core in the plan may be different, they are buildings with one, two or several cores. The shape of the core may vary, too. It may be of the single-box type, multi-box type, or any other open or closed shape.

The core and the other vertical and horizontal parts of the structure may be statically interdependent and constitute various statical systems. In any case it can be supposed that there is a uniform system resisting both the vertical and the horizontal loads. It should also be taken into account that in the course of the erection the sructure may come to different stages of behaviour and may represent different statical systems unlike the finished structure.

The fundamental systems are shown in Fig. 1

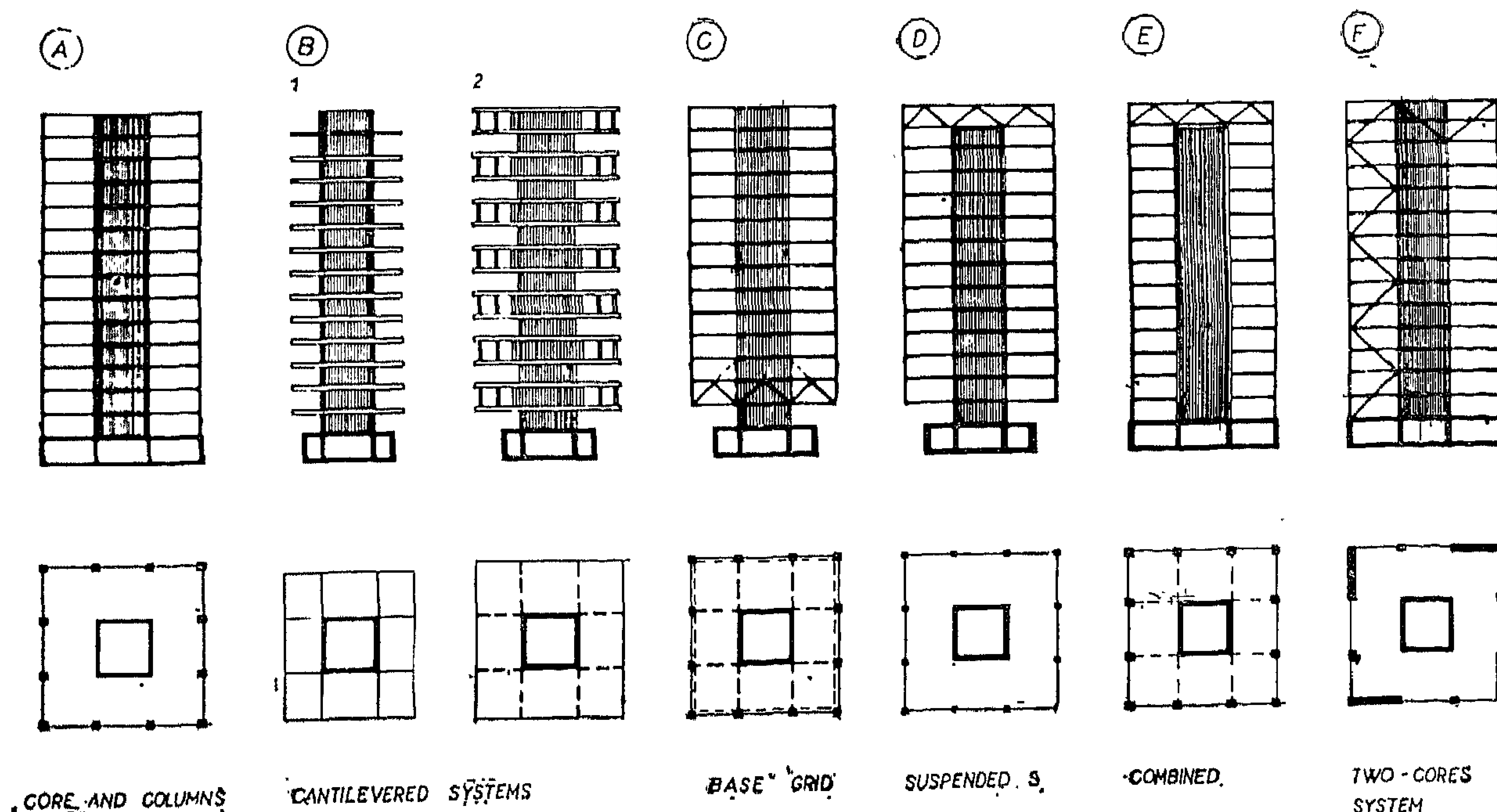


Fig. 1 Various statical systems with internal cores.

In the fall of 1957 Khan did return to East Pakistan. He did consulting work and later took a job as executive enyineer with the Karachi Development Authority. The job had great status, but because he became too involved in administrative tasks, Khan began to feel the position kept him from the design work he wanted. He wrote to SOM, received an affirmative response, and he and his wife returned to Chicago in June, 1960.

First jolt. Khan's first job as project engineer was the 38-story Brunspick office building in Chicogo. For it, he proposed the first shear wall-frame interaction design, a forerunner of tubular design. The building's shear wall is connected to the outer frame with floor diaphragms to provide a bracing system against wind. "The Brunswick Building is built like a watch in the sense that we looked at ev-Khan. As a result, he produced 500 charts erything that could ever go wrong," says to show its behavior under all conditions. This job also gave Khan his first professional jolt.

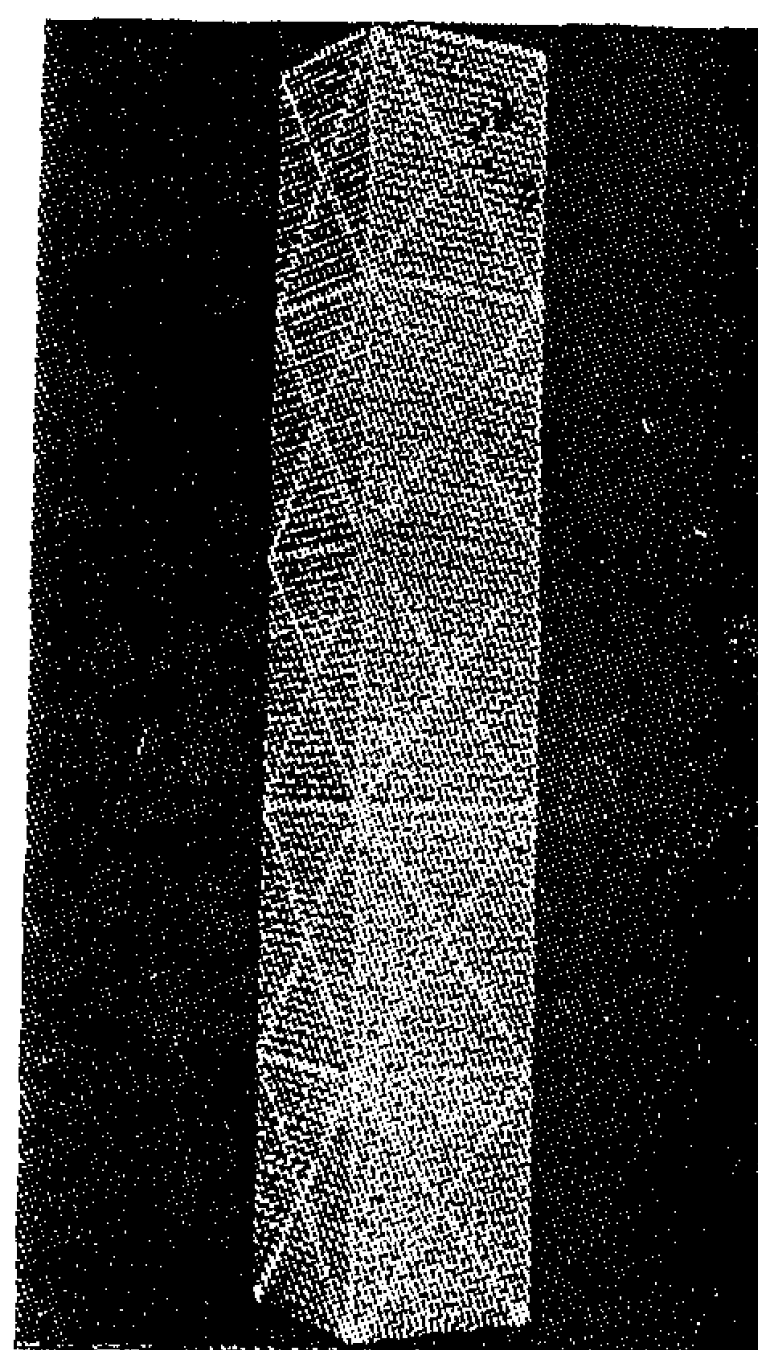
After lcnch one day, Khan says, he received a phone call from the SOM chief engineer who said that the building was being shored beacuse it was on the verge of collapse. Large cracks were spotted in the floor slabs. "I really felt nervous," says Khan, who is normally composed and confident.

Immediately Khan and others from SOM went to the building. To Khan's relief, the cracks turned out to be slots cast in the slabs' corners, according to design, to relieve stress that was expected to develop first project and I thought my last."

Now, as partner, working with an engineering staff of 35, Khan says, "Wherever there is crisis, that's where I am."

No ulcer, no tension. Khan says, "Every man must have a philosophy in this age of tension and aggression. I look at everything in my life on a very philosophical level. I don't look at my work as personal goals, but I look at it as smething that I enjop and something that has social value." Khan boasts that he has no ulcers or nervous tension even though he works many Saturdays and Sundays and many weeks travels from 2,000 to 4,000 miles.

On Saturdays, he teaches at the Illinois Institute of Technology as an adjunct professor of architecture. He works on projects with students, such as a 110-story con rete tube that Khan predics will soon be reality (see photo).



Hint of future buildings.

Despite his tight schedule, he gets in meetings of the Chicago Committee on High-Rise Buildings, of which he is the founding chairman; the American Society of Civil Engineers (ASCE); Mayor Richard Daley's Advisory Committee on Codes; and the steering committee of the Joint Committee on Tall Buildings, established by the ASCE and the International Association for Bridge and Structural Engineering. He is sole author and with others of over 65 technical papers.

and then explains the details of some of his innovations. Suddenly, shots of crowded, smog-covered Chicago and New York City appear on the screen. Khan then cuts to shots of buildings with tree-filled, fountain-filled, people-filled plazas. While this is going on Khan expounds on how designers have got to face up to urban problems and let their consciences push them in that direction.

Structural empathy. That the 110-story Sears Tower breaks a height record was not Khan's motivation. Going that high was simply the best solution to a problem. Says Khan, "Sears wanted 4.4 million sq ft of space. The building went 1,450 ft because we at SOM wanted to maintain adecent environment at ground level, which is why the building has a plaza that will be dotted with art pieces."

Khan's thought process is based on empathp for structures. He says, "When thinking design, I put mpself in the place of a whole building, feeling every part. In my mind I visualize the stresses and twisting a building undergoes."

Tubular design was born from this empathy. Partner Graham asked Khan what the most economical building would be. Khan said one with thin solid walls, like a tube, so that it reacted to wind like a vertical cantilever and thus eliminated shear racking. He then said, "But we've got to live in it, so we punch small holes in the tube for windows, getting approximately the same structural effect."

Graham liked the idea and both went ahead with the plan for the 43-story DeWitt Chestnut apartment building.

Dacca is Khan's birthplace. His father was a well-known scholar and mathematician, who held the highest position in the country's educational system.

Mystical and mechanical. When Khan and his father were discussing whether he should study physics or engineering, his two choices, his father suggested that engineering would be better because it demanded discipline. Khan admits, though, that at the time the engineering challenges in India and East Pakistan looked more promising than the challenges in physics, and this influenced his decision.

"I liked physics because of its mystical and abstract aspects," says Khan, "but I was good in mathematics and always tinkering with something mechanical."

After completing his undergratuate work at the Bengal Engineering College, where he graduated at the top of his class, he worked for two years as an assistant engineer for the highway department and taught at the University of Dacca. In 1952 he qualited as a Fulbright scholar, and also won a scholarship from the Pakistani government. As a result he enrolled at the University of Illinois, Urbana, for three years. He completed enough credits for a master's in applied mechanics and a master's and doctorate in structural engineering.

Khan got his job at SOM by chance. After receiving his doctorate, at which time he was considering offers from top engineering firms across the country, he met a friend on the street who worked at SOM. The friend told Khan of the exciting projects in the SOM office. Khan went directly to SOM, had an interview, got an offer and immediately accepted at a salary considerably less than any other offer.

He accepted the SOM offer because the firm gave him responsibility immediately, "My first project was complete charge of seven prestressed bridges at the U.S. Air Force Academy in Colorado Springs, Colo. Those other firms told me I'd start on some beam analysis. I didn't feel I would get any experience before I had to return to East Pakistan in a year and a half, a stipulation of the scholarships."

with architecture integrated as part of the whole. This group thinking results in a systems building that satisfies all requirements"

With this kind of sensitivity and the general SOM philosophy that a structure shouldn't be covered with a fake facade, Khan has developed his own philosophy of design. The governing factor in his theory is to use the natural beauty of mathematically derived form and the inherent beauty of material to create livable building for man.

"A building's natural strength should be expressed," says Khan. Probably Khans best expression of structure is the John Hancock Building. On its exterior, six sets of diagonals criss-cross each other along the faces of the building. Inside, these diagonals are visible in offices, apartments and restaurants. One Shell Plaza uses structural design for esthetic expression. Its perimeter columns vary depth, some columns extending further out than others, to create a ripple effect along the exterior. The deeper columns support greater loads. depending on their particular location.

Khan also believes in a pure expression of a building's material. He doesn't believe in using granite slabs on a steel frame or attaching aluminum sheets to a concrete building.

Khan has definite ideas for implementing his philosophy of structural expression. He says, "Many architects are brought up to think that they are the only creators and that the engineers are technicians. This must stop. The engineer has to be an architect to the extent that the architect has to be an engineer so that in combination they produce the creative building".

How to appreciate life. Although thoroughly steeped in engineering, Khan is not a slave to the technical. "The technical man must not be lost in his own technology. He must be able to appreciate life, and life is art, drama, music and, most importantly, people," says Khan. This theory prompts Khan to say, "The social and vicual impact of buildings is really my motivatin for searching for new structural systems."

Khan designs for the owner by cutting costs. Khan designs for people by giving close attention to what happens at ground level where people and a city's facilities together. By going high with his structures he leaves maximum space for a surrounding plaza.

It's because of this belief that Khan has no qualms about going as high as possible with buildings. "We need the area on the ground, not up in the sky. We can never hope to have cities with the appearance of those in Europe that are mostly low-rise," he says.

Europe does in fact present a new frontier for Khan. European cities also need space for work and shelter, and the only way to go is up. With his partners, Khan has completed structural design of one building in the Netherlands and one in Paris. Construction of the Paris project is being delayed by the Paris planning commission.

European architects and engineers however, are already familiar with Khan's work through their visits to this country and through photographs illustrating articles, some of which Khan wrote, in various accomplishments, he has become a sought-after speaker for professional meetings in Europe.

On one trip, Khan was scheduled for a single talk in London. He ended up giving eight talks in six countries, because before Khan left Chicago, word had spread in Europe that he would be in London. Engineering, as well as architectural groups from Paris, Stuttgart, Munich, Milan, and Vienna asked for his time.

Invariably, when Khan lectures on high-rise buildings, he first goes through a brief slide-supplemented history of tall buildings,

pensive internal wind bracing, which is typical of conventional design. Since development of the concept and its initial application by Khan in 1963 in a 43-story, reinforced concrete Chicago apartment building, tubular design appears in four of the world's five tallest buildings: the 1,350-ft-high World Trate Center towers in New York City, second highest buildings in the world; the 1,136 ft-high Standard Oil Co. (Indiana) Building in Chicago, fourth highest; the 1,450-ft-high Sears Tower and the 1,105-ft-high John Hancock Building, Chicago, fifth highest. The third highest is the 1,250-ft-high Empire State Building, in New York City, which uses a conventional frame, topped out in 1931. The 44-year-old Khan has obviously influenced tall building design, for the World Trade Center Towers and the Standard Oil Building are the work of others.

Khan's first steel version of the tube is the John Hancock Building. The design, completed in 1965, saved $ 15 million and resulted in a structural steel weight of 29 lb per sq ft (140 Kg./sq.m.) for the 100-story structure, Originally, the plan for the Hancock project called for two separate buildings, one office building and one apartment building. Bruce Graham, Khan's architectural partner in the Chicago office of Skidmore, Owings & Merril (SOM), where Khan is partner in charge of structural engineering, suggested the design of a single building containing both occepancies. Khan said it could be done by using the diagonallp braced tuge in which the diagonals achieve the tube concept by spreading the load to all perimeter columns, while simultaneously carrying their share of gavity loads.

Concrete milestone. Another mile-stone building is the 52-story One Shell Plaza. It uses the concept Khan calls tube-in-tube, which has closely spaced perimeter columns to handle the wind and an inner tube, consisting of the building's core walls, to handle the dead load on the building's interior. On that project, Houston developer Gerald Hines wanted to go as higher as possible with a concrete building. Khan's tube-in-tube design of lightweight concrete resulted in a cost per square foot comparable to that of a 35-story building. The bulding's cost was $22 million,

On the Sears Tower, Khan's structural design saved $10 million by using the modular tube system, a variation of tubular design. This building consists of nine continuous steel modules, each 75 ft square in plan. (523 sq.m) They form the tower's 225 x 225-ft dimensions from grade to the 50th floor where two modules drop off. Two more drop off. at the 66th and three at the 90th floor leaving only two that go the full 1, 450-ft heiyht. The modules have common interior columns that make up two diaphragms, trisecting the building in two direction to stiffen the structure. The weight of the $ 150-million, 110-story structure is 33 lb per sq. ft. Khan estimates that conventional tubular design, without diaphragms, would have resulted in a steel frame weight of 60 to 70 lb per sq ft.

The composite buildings, a 24-story office tower in Houston, a 36-story tower in Chicago and a 50-story tower in New Orleans, represent Khan's latest modification of the tube. This design uses concrete perimeter columns to handle the wind load and a steel interior frame to take the dead load. Actually, the perimeter clumns are slender steel members that are part of the whole steel frame, but which are encased in concrete as the building goes up. On these buildings, Khan cut structural cost by 15% and steel requirements by 50%.

Such achievements, and, perhaps more than anything else, Khan's blend of technical expertise and sense of esthetics, made him in 1970 the only engineer partner out of a total of 20 partners at SOM. All the others are architects. Says Khan, "The greatest step the building team has made in the past decade is that the engineer, as part of that team, is finally looking at the whole structure

FAZLUR R. KHAN

Visits Cairo: March 29th - April 4th, 1947

Combining technical genius with a sensitivity for people and the places in which hey must live and work in our cities, strucural engineer Fazlur Khan has come up with nnovation after innovation that cut costs while simultaneously pushing buildings igher. His advances in structural design are ontained in the diagonally braced John Hanock Bulding in Chicago; One Shell Plaza in Iouston, the highest allconcrete building in he world; three composite buildings, in Iouston, Chicago and New Orleans; and the Sears Tower, the world's highest building, n Chicago. All of these structures use the oncept called tubular design, which Khan volvet over ten years ago.

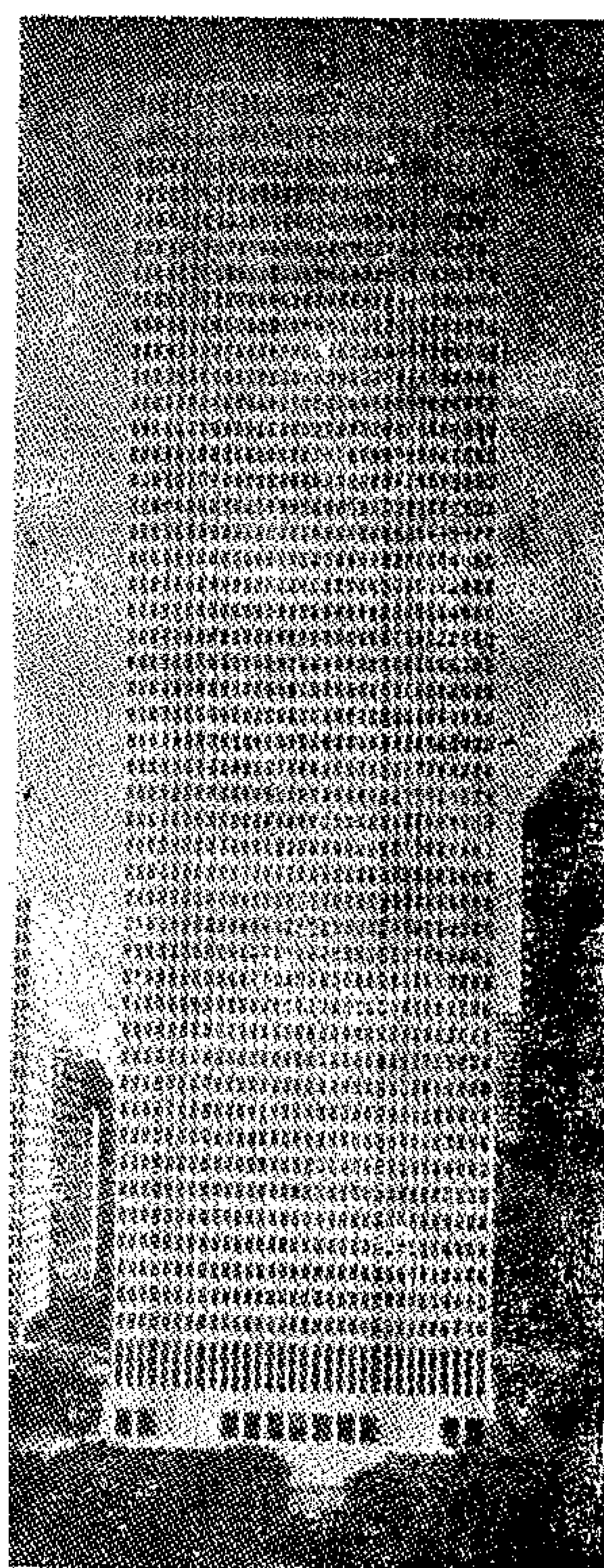


His buildings : innovation for economics & the urban environment.

Tubular design contributes to economical onstruction of tall buildings because it llows a building's perimeter columns to erve as wind bracing, thus eliminating ex-



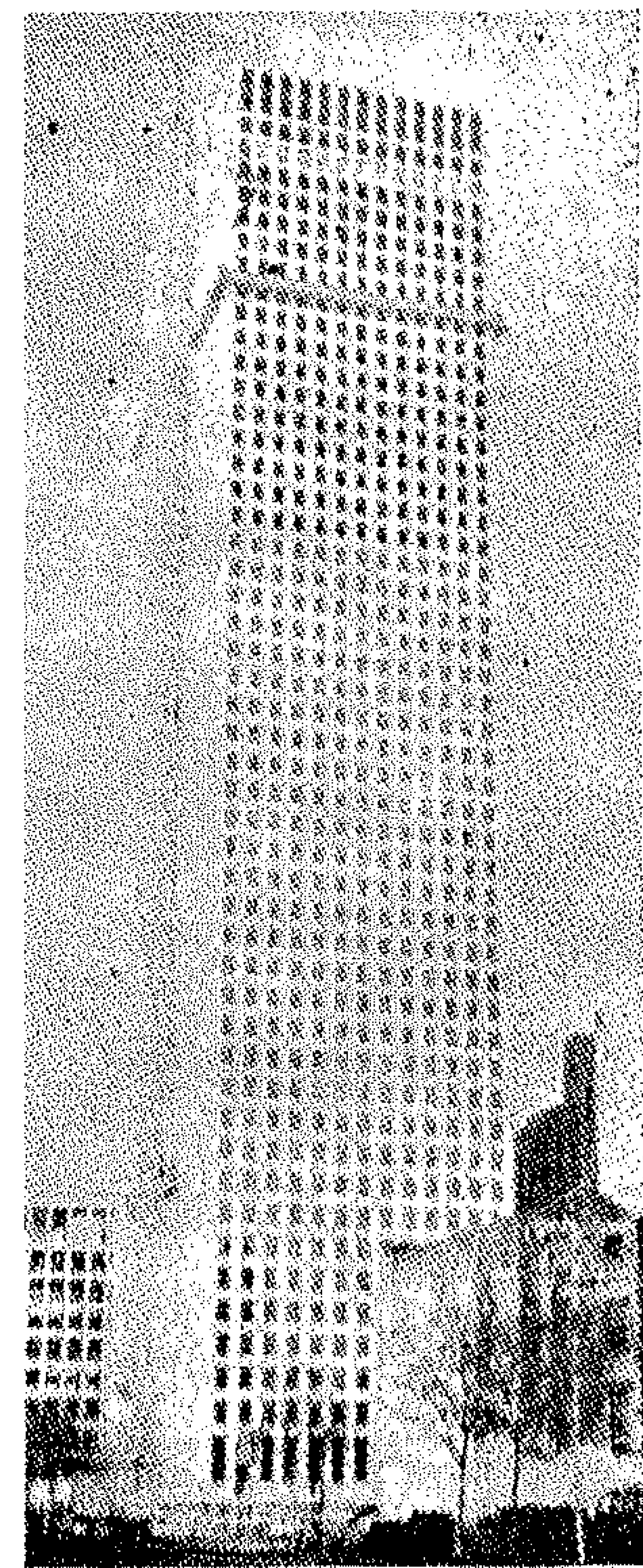
1965



1968



1970



1971

ited previously by ENR are Khan's systems for the John Hancock, One shell Plaza, Sears & Composite buildings.

vited. Dr. Adam Wysocki, Director of the Division of Information and Scientific Documentation of UNESCO, has already agreed to speak and an invitiation has been extended to Mr. Roch T. De Mautort, Chief of the Industrial Information Section of UNIDO.

It is also planned to include speakers from developing countries such as Mexico Bulgaria, Nigeria. and India, as well as representatives from developed countries such as the USSR, UK and FRANCE. Egyptian Society of Engineers will arrange for papers and speakers from Egypt and other Arab countries. These speakers will discuss availability of engineering information services within their countries and propose demonstration programs.

Subsequent sessions will be devoted to a discussion of the presented papers and to the adoption of apecific recommendations for action on the part of UNISIST, the CHI, or other organizations concerned with engineering information. These sessions will be followed by the formal WFEO meeting at which time plans will be developed for implementing the adopted recommendations.

LANGUAGES OF MEETING :
English, French, Arabic

OBJECTIVES :

1. To examine the availability of engineering information in developing countries and to indentifly actions by the World Federation of Engineering Organizations' Committee on Engineering Information which can assist in making relevant reliable information more accessible in developing countries.
2. To make specific recommendations for improving the transfer of engineering information in developing countries.
3. To develop demonstration programs for transferring engineering information in developing countries which could serve as a model for other developing regions.

TECHNICAL PUBLICATIONS PLANNED :

Papers by representatives of industrialized developing countries on the availability of engineering information in their countries; recommendations for improved engineering information services within developing countries; plans for demonstration programs.

For further information write to :

DR. GAMAL NASSAR

Conference Secretary Egyptian Society of engineers, Ramsis Str. 28, Cairo.



TECHNICAL CONFERENCE ON ENGINEERING INFORMATION IN DEVELOPING COUNTRIES — 26 APRIL, 1974

INTRODUCTION

The World Federation of Engineering Organizations (WFEO) is an international, non-governmental organization formed in 1967 in an attempt to bring together all of the engineering organizations of the world. The formation of the organization was partially initiated through the interests of two activities in the United Nations, UNESCO (which is concerned with education, science, and culture) and UNIDO (which is concerned with industrial development). At the present time, representatives of the various engineering organizations in 70 countries make up the membership of WFEO. A list of these countries and their representatives is included in Appendix A. The objective of WFEO is to advance engineering as a profession in the interest of all people and to encourage the application of technology to economic and social advancement throughout the world. WFEO is the engineering counterpart of the International Council of Scientific Unions (ICSU).

The Committee on Engineering Information (CEI) is an active standing committee of WFEO. It was set up in 1969 upon the recommendation of a special working group of the WFEO. It held its first meeting in Map 1970 and has met annually since that time. It consists of engineering information experts from 16 countries. The objective of the CEI is to improve the techniques for communicating engineering information, to identify deficiencies in the communication of engineering information, and to provide means for remedying such deficiencies. The Maczelna Organizacja Techniczna Organization) (NOT) of Warsaw, Poland acts as its technical Secretariat.

The CEI has working groups studying such topics as the engineering information services throughout the world, the needs of the user of engineering information, and topics related to engineering data. The latter effort will be closely integrated with ICSU's Committee on Scientific and Technical Data (CODATA). CEI also has a major interest in working on programs for the better transfer of engineering information to developing countries. The fifth annual meeting of the CEI will be held in Cairo, Egypt, the week of April 22, 1974.

IMPLEMENTATION

In conjunction with the fifth annual meeting of the CEI, an invitational conference will be held on April 22 through 26. The conference will be under the auspices of the WFEO-CEI in conjunction with the Federation of Arab Engineers, the Egyptian Society of Engineer and the Ministry of Housing & Construction. The topic of the conference is engineering information problems in developing countries. It is, therefore, appropriate to hold the meeting in Egypt, a developing country with a vital interest in industrial development.

The five-day conference will be made up of a numger of sessions and will include papers by engineering information specialists from both industrialized and developing countries. These specialists will provide a broad global perspective of engineering information. Also repressentatives of UNESCO and UNIDO will be in-

is underway with particular interest in tall buildings.

. Serious lack of written information on social effects of environment. There is no "model" available and no criteria exist to evaluate quality of life.

. The concrete construction process called "Progressive Strength" facilitates a 3-day cycle and eliminates need for floor formwork.

. Techniques for computer analysis that conserve computer time.

. The learning process also applies to motion perception, "People aren't as concerned in their second storm".

. Foundations are a special problem because of the high water table — and considerable depth to rock.

. World's tallest concrete building, 70-stories, 850 ft. Water Tower Plaza in Chicago. Mixed use.

. "Hi-Rise Committees" in major cities are facilitating dialogue between design professionals, developers, government decision makers.

. Multi-story apartments for low income people remain a pressing problem the world around.

Egypt Impressions: Real estate still disappearing to spreading cities... The surprising size of the Pyramids, Luxor temples and Abu Simbel statues of Ramses II (raised above the Aswan waters)... the view of the pyramids and desert from the Nile Hilton (will construction on the opposite bank obliterate it?).... Old Cairo, its bazaars, throngs, Coptic area, synagogues (over spot where Moses was found in the bullrushes). Mosques... the continuing construction to relocate ancient temples above the new water levels up the Nile... the close interaction between the designers and Cairo government officials, facilitating use of new concepts, the warmth, friendliness, and hospitality of the Egyptian people.

P.S. We knew we made an impact, but didn't realize they would jump to more than twice their present height (see box) !



As in some other conferences "Why Tall Buildings" came in for considerable informal discussion. It was the first theme. Others were (Urban & Architectural Planning", "Structural Design", **"Foundations"**, "Construction", and **"Services"**. Headquarters shortly.

Advance copis of papers should be at Headquarters shortly.

The coincidence of the Cairo Conference with Kissinger's discussions interfered with our post Conference tours a bit (we saw his plane 3 times). But no one really cared in view of the unanimous confidence on the part of all that the efforts would lead to success. The fact that they did — and while we were there — made us feel almost a part of the negotiations.





Topics of Note :

Concern for a growing wall of tall buildings along the Nile (we won't be able to see the pyramids).

Life in tall buildings illustrates our ambivalent nature in our desire for privacy on the one hand and our need for social contacts on the other.

Present tallest : 32 stories Belmont & Sheraton. Projected are 40 floors and more.

Urban planning and regional planning

TALL BUILDINGS NEWS

HIGHLIGHTS FROM CAIRO CONFER ENCE

On the occasion of the Regional Cairo Conference on Tall Buildings, held in Cairo during the period 14 to 17 January, 1974, the Headquarters at the Fritz Engineering Laboratory published and circulated a special edition of the TIMES.



This special edition is circulated to all the Members of the Steering Group and the Editorial Committee in 51 Countries. Professor Lynn S. Beedle, Chairman of the Joint Committee, writes :

A visitor to Cairo, in recent years would have anticipated a warm welcome, but who would have expected a banner across the airport entrance and special guidance through entrance formalities ? National Representative Gamal Nassar, Conference Chairman Dr. Moharram and Deputy Chairman Eng. Kaddah led 320 participants from 23 countries through a full week of sessions, receptions, luncheons, dinners, and tours of pyramids (old and new) and temples of Luxor and Abu Simpel.

Of all conferences to date, this 21st provided the most contacts between professionals and government leaders. We met 5 members of the present cabinet and a number of former ministers. (11 of the present ministers are engineers). Opened and closed by the Minister of Housing and Development (Dr. M. A. Abdel Hafez) both he and the Minister for Rehabilitation (Mr. O. A. Osman) urged continued contacts with planning, design and construction specialists from developed countries. Wt feel sure such contacts are possible and desirable and can be implemented.

A National Committee on Tall Buildings is being established in Cairo to be sure the contacts continue with the Joint Committee. They nave established a reference library.

The PL 480 money came through, but so late that it was a scramble both from the Lehigh and Cairo sides to arrange everything. The Cairo performance under this pressure was outstanding. They arranged for representation from nearly the whole of the Arab world. Headquarters arranged 31 from other countries, from as far away as Australia, Japan, Canada, Britain, India, Europe, Africa and the U.S.A. (from which there were 14 delegates.) Since all visitors participated as speakers, the program provided a fine mixture.

If the tall building is left without control, its advantages would turn out to be drawbacks. They should be dealt with in master plans.

مبـــــانى الجـــــراجات

دكتور عصام الدين بدر
أستاذ العمارة المساعد بكلية الهندسة
جامعة القاهرة

دكتور محمد سامى الشافعى
أستاذ العمارة المساعد بكلية الهندسة
جامعة القاهرة

سياسة انشاء مبانى الجراجات :

ظل إنشاء الجاراجات وتوفير وسائل الانتظار بصفة عامة حتى عهد قريب فى كثير من بلاد العالم يعتبر موضوعا خاصا يقوم به الأفراد لاستثمار أموالهم سواء داخل المدينة أو فى ضواحيها ، وحتى فى البلاد التى زادت فيها نسبة استعمال السيارة زيادة ملحوظة ـ كالولايات المتحدة وبعض الدول الأوربية ـ لم يمثل موضوع انتظار السيارات بالنسبة للقائمين بمسئولية التخطيط أمرا هاما يجب حله على مستوى الدولة حتى بدأت الحياة التجارية فى قلب المدينة تتأثر تأثرا ملحوظا نتيجة لتزاحم السيارات فى الشوارع والميادين وعدم وجود الأماكن المناسبة لانتظار السيارات العاملين بقلب المدينة والعملاء الذين يقصدونها وكذلك سيارات الخدمة المختلفة وهو الأمر الذى هدد الحياة الاقتصادية للمدينة بالشلل . وقد بدت هذه الصورة واضحة فى أعقاب الحرب العالمية الثانية وتطور صناعة السيارات وزيادة انتاجها زيادة كبيرة فتدفقت السيارات بأعداد كبيرة داخل المدن وظهرت مشكلة انتظار السيارات الى الوجود كمشكلة عامة تخص الدولة ، خاصة وأن جميع الحلول المتعلقة بها لا يمكن أن تتم الا على نطاق التخطيط العام للمدينة ، وبدأ المسئولون فى المدن المختلفة خاصة فى الولايات المتحدة وألمانيا وضع الخطط المناسبة لمعالجة الأمر .

ففى عام ١٩٤٧ تأسست فى مدينة بتسبرج بولاية بنسلفانيا « هيئة الانتظار العام » (Public Parking Authority) كهيئة استشارية لا تتبع البلدية ولا تمثل جهازا تنفيذيا وتتكون من خمسة أعضاء يمثلون مجلس الادارة ويختارهم حاكم المدينة ويقوم بالأعمال الادارية والفنية بالهيئة مختصون فنيون ، وتنحصر مهمة الهيئة فى تحرى الحلول المناسبة لمشكلة الانتظار بالمدينة وعمل الأبحاث والاحصاءات اللازمة واقتراح الأماكن المناسبة كما كان من واجبها عمل المشاريع المختلفة بواسطة الفنيين التابعين لها أو الاشراف على المشاريع التى تقوم بها المكاتب المختلفة لحسابها وكذلك الاشراف على ادارة المنشآت المختلفة للانتظار .

ومن أوائل الأعمال التى تمت تحت اشراف هذه الهيئة مشروع جاراج متعدد الأدوار تحت الأرض أسفل ميدان ميلون Mellon بمدينة بتسبرج والذى قامت بتنفيذه شركة H.K. Ferguson Co. ويقع هذا الميدان داخل منطقة الأعمال بوسط المدينة وكان يشغل مكانة قبلا مجموعة من المساكن المتداعية القديمة قامت الهيئة بالتفاوض مع أصحابها وتحديد التعويض اللازم لهم لازالتها وعمل مشروع لجاراج من ستة أدوار تحت الأرض يسع ٨٩٠ سيارة ، وقد كان مقررا أن يقام هذا المبنى فوق الأرض ولكن لاعتبارات خاصة بتخطيط المدينة تقرر أن يكون تحت الأرض على أن يعلوه ميدان عام يتكون من مستويات مختلفة حسب تصميم الجاراج ، وبذلك حققت الهيئة للمدينة حلا جزئيا لمشكلة الانتظار دون التضحية بجزء من الأرض مرتفع القيمة أمكن الاستفادة منه كعنصر من عناصر تكوينها .

وما حدث فى بتسبرج نجد نظيرا له فى شيكاغو حيث أنشأ مجلس البلدية الخاص بها فى عام ١٩٥٠ مكتبها لهذا الغرض أطلق عليه « مكتب انتظار السيارات » Bureau of Parking وقد كانت له نفس وظائف هيئة الانتظار العام فى بتسبرج ، وقد قام هذا المكتب بدراسة وسائل الانتظار اللازمة للمدينة كلها ففى مركز المدينة حيث تزيد كثافة المرور وأسعار الأراضى اقترحت الجاراجات المناسبة التى تعتمد على الوسائل الميكانيكية فى نقل السيارات من والى مكان الانتظار كما اقترحت الجاراجات ذات المنحدرات حيث تتوفر الأرض اللازمة لانشائها سواء منها المستخدم بواسطة العميل نفسه أو بواسطة أحد العمال attendant أما فى الضواحى فقد خصصت مساحات كافية للانتظار فى الأماكن المناسبة .

وقد اقترح المكتب أن يكون تنفيذ برنامجه هذا على مراحل مختلفة وبتمويل ذاتى لا تتحمله الحكومة وفى عام ١٩٥٠ أصدرت سندات قروض

بلغت قيمتها ٤١ مليون دولار وذلك بغرض تنفيذ مشاريع الانتظار للسيارات على أن يتم تسديد هذه السندات من عائد وسائل الانتظار المختلفة سواء كانت مبان متعددة الأدوار أو أماكن أو عدادات الانتظار .

وقد حذت بعض المدن الأوربية حذو المدن الأمريكية فى هذا المجال ففى مدينة فرانكفورت مثلا بألمانيا تأسست هيئة باسم .Aufbau AG التى قامت بالاشتراك مع المدينة بتخطيط وتنفيذ وادارة أماكن الانتظار بها وحتى عام ١٩٦٢ كان قد تم انشاء ستة مبان لانتظار السيارات وانتهى العمل من تصميم عشرين أخرى أما فى دوسلدرف فقد اكتفى المسئولون بالعمل على توفير أماكن الانتظار المناسبة على أن يقوم الأفراد أو الشركات بانشاء مبان للانتظار عليها يقومون بادارتها نظير عائد يحدد حسب طبيعة الموقع والمنشأ المقام عليه يدفع للحكومة ، وقد أخذت المدينة بهذا الاتجاه فى التمويل تحقيقا لمبدأ الاقتصاد الحر الذى نادى به الأستاذ تامس Prof. Tamms المسئول الأول عن تخطيط المدينة وهو يرى أن تكتفى البلدية بتوفير الأراضى المناسبة على أن يقوم القطاع الخاص بعد ذلك بالمشاريع المختلفة عليها .

وأيا كان الاتجاه فى معالجة مشكلة انتظار السيارات فانه من الواضح أن تدرس هذه المشكلة سواء من الناحية التخطيطية أو المعمارية على أساس اعتبارات التخطيط العام للمدينة بحيث تصبح مبانى انتظار السيارات وأماكنه جزءا أساسيا من مكونات المدينة .

وتنقسم مبانى الجراجات بصفة عامة الى نوعين رئيسيين الجراجات الميكانيكية والجراجات ذات المنحدرات ، وأولهما وهو الجراجات الميكانيكية وتتميز بامكان انشائها على مساحات من الأرض صغيرة نسبيا أو ذات شكل غير منتظم مما يجعل تطبيق استعمالها فى مراكز المدن ذات الأبنية المتقاربة أمرا منطقيا ، والواقع أنه بالرغم من ارتفاع تكاليف التركيبات الميكانيكية بهذا النوع من الجراجات الا أنه تكاليفه الانشائية تقل بدرجة كبيرة عن الجراجات ذات المنحدرات ، ويتم فى هذه الجراجات نقل السيارة من مكان الاستقبال الى أماكن التخزين ثم استلامها بعد ذلك بطرق ميكانيكية ولا يسمح لقائدها بالتجاوز عن مكان الاستقبال الى أماكن الانتظار داخلها بل يتم العمل بعد ذلك بطريقة آلية .

والنوع الثانى من الجراجات وهو الجراجات ذات المنحدرات والتى تعتمد على وجود مستوى مائل هو المنحدر تقاد عليه السيارة الى مكان الانتظار الخاص بها اما بواسطة قائد السيارة نفسه أو أحد العمال المختصين بذلك .

الجراجات الميكانيكية Mechanical Garages

تعتمد فكرة الجراجات الميكانيكية على نقل السيارة عند وصولها الى مبنى الانتظار بصالة الاستقبال الى المكان المخصص لها للانتظار بطريقة آلية ويتم ذلك باستخدام المصاعد شكل (١ ، ٢ ، ٣ ، ٤ ، ٥) أو يتم تخزين السيارة باستعمال أماكن انتظار متحركة تدخل اليها السيارة مباشرة من صالة الاستقبال شكل (٦ ، ٧ ، ٨ ، ٩) .

ويتطلب تخزين السيارة فى حالة استعمال المصاعد حركات أفقية وراسية ، أما الحركات الأفقية فهى انتقال السيارة من صالة الاستقبال الى داخل المصعد ثم من المصعد الى مكان الانتظار وبالعكس وهى تتم اما بقيادة السيارة بواسطة أحد العاملين أو ميكانيكيا بواسطة أزرار داخل المصعد يقوم بتشغيلها عامل متخصص والحركة الراسية تنحصر فى انتقال السيارة بالمصعد الى طابق الانتظار ، ويمكن تشغيل المصعد ليخدم مجموعة من أماكن التخزين فى صف راسى أو على جانبين منه كما يمكن فى حالة استخدام برج متحرك لمصعد يتحرك أفقيا خدمة عدة مجموعات من أماكن التخزين سواء على جانب واحد منه أو على الجانبين ، وفى بعض الأمثلة تتم عملية التخزين بجميع الحركات اللازمة لها أوتوماتيكيا من مركز خاص بذلك به أزرار ضاغطة يقوم بتشغيلها موظف مختص أو العميل نفسه عند وصوله الى صالة الاستقبال .

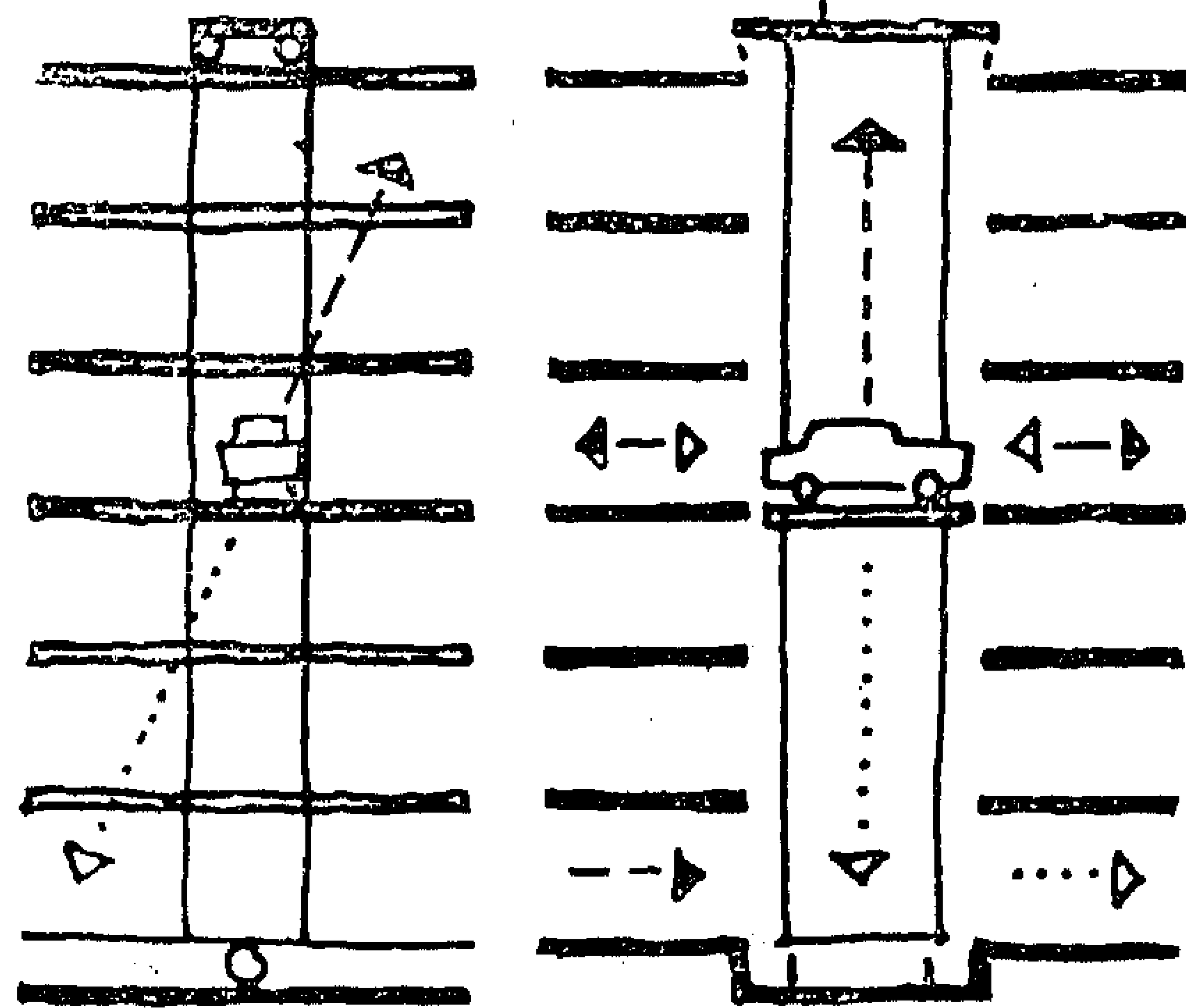
اما طريقة استعمال أماكن الانتظار المتحركة فتعتمد على أستخدام وحدات للتخزين تتحرك الى صالة الاستقبال حيث يقود السائق سيارته الى داخلها وتتحرك وحدات التخزين بواسطة سيور ناقلة تدور فى مستوى راسى أو بواسطة عجلات دائرية ضخمة تعلق فيها الوحدات ، وقد طبقت هذه الطريقة فى عدة نظم مختلفة ولكنها لم تنفذ الا فى نطاق وحدات صغيرة نظرا للوقت الطويل الذى تتطلبه عملية تخزين السيارة أو استعادتها فى الوحدات الكبيرة من هذا النوع من الجاراجات .

ويجب العناية عند تصميم الجراجات العامة الكبيرة بالمدينة أن يتناسب تشغيلها وحركة المرور الكثيفة فى الأوقات الحرجة من اليوم Peak hours ويراعى بصفة عامة أن يكون ممكنا تخزين ما لا يقل عن ثلثى سعة هذه الجراجات من السيارات خلال ساعة واحدة وتشير الدراسات فى بعض الحالات الى الحاجة لتصميمها بحيث يمكن شغل أماكن

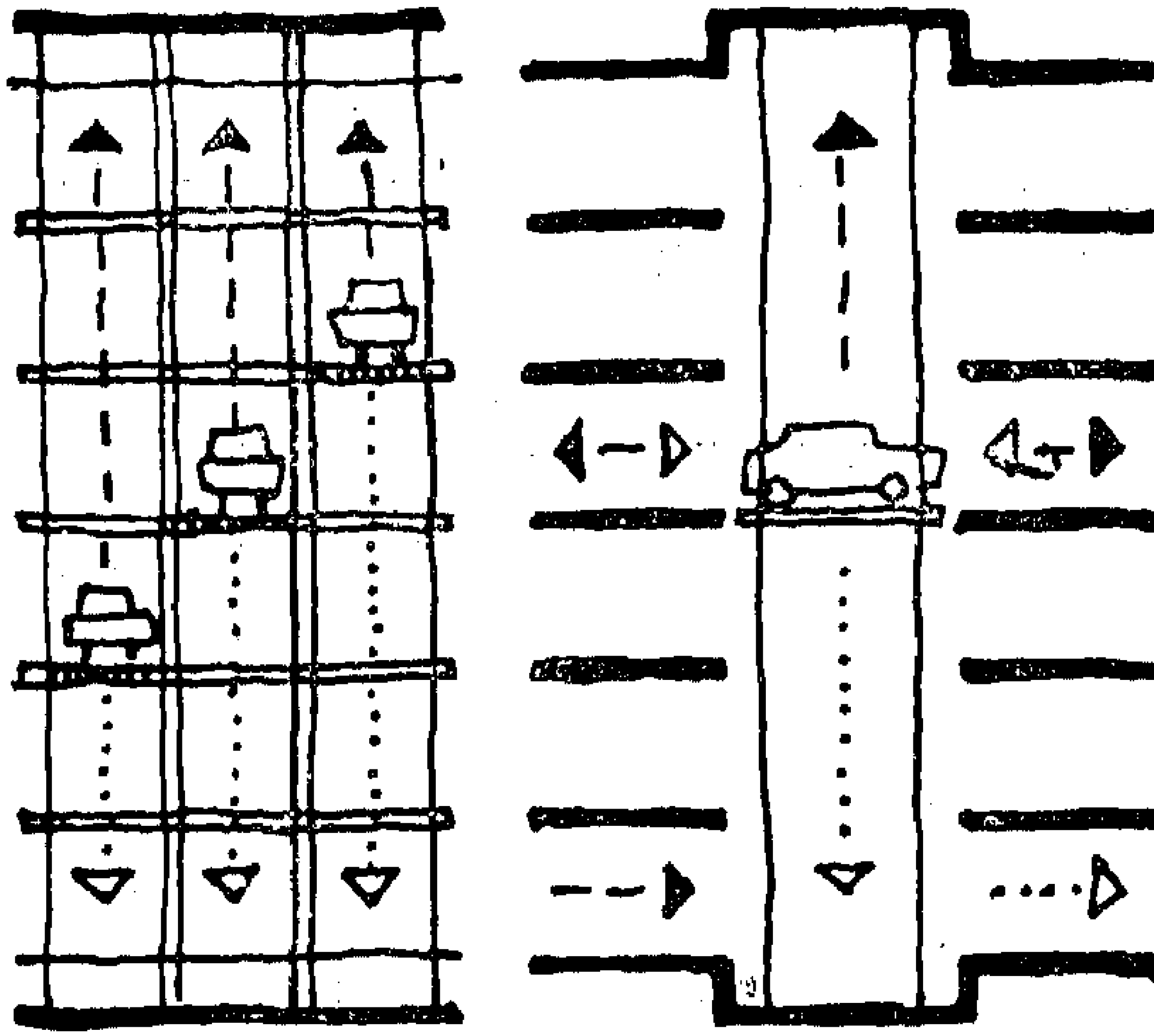
الانتظار كلها خلال ساعة واحدة ، وبمراجعة بعض الأمثلة التى نفذت من الجراجات الميكانيكية نجد أن كثيرا منها تقل قدرة استيعاب السيارات به عما تتطلبه حركة المرور الكثيفة فى الأوقات الحرجة الأمر الذى يتطلب ضرورة توفير مكان كبير لتخزين السيارات لحين نقلها الى أمكنة الانتظار الخاصة بها بواسطة المصاعد .

وبمقارنة الجراجات الميكانيكية بالجراجات ذات المنحدرات نجد أن المساحة المخصصة لانتظار السيارات تتساوى فى الحالتين فى حالة الاعتماد على العمال لوضع السيارات فى الأمكنة المخصصة لها حيث يجب أن يتم وضعها بحيث يترك الفراغ اللازم الذى يسمح لقائد السيارة بمغادرة السيارة أو الدخول اليها ويختلف الأمر فى حالة الجراجات التى تشغتل أوتوماتيكيا بالكامل Fully automatic والتى توضع السيارات فيها الى جانب بعضها دون الحاجة الى ترك فراغات كبيرة بينها ، كذلك تتساوى المساحة المخصصة للسيارة بالنسبة للمبنى كله فى حالة الاعتماد على العمال فى كلا من الجراجات الميكانيكية والجراجات ذات المنحدرات وذلك لضرورة توفير المساحات اللازمة أمام المصاعد لدخول السيارات اليها أو عند الخروج منها فضلا عن المساحات الكبيرة اللازمة لتخزين السيارات حتى يتسنى نقلها بواسطة المصعد الى مكان الانتظار بالأدوار المعدة لذلك ، أما فى حالة الجراجات التى تعمل أوتوماتيكيا بالكامل وبسرعة ملائمة فان المساحة الكافية للمبنى تقل بدرجة محسوسة عن المساحة المطلوبة للجراجات ذات المنحدرات .

وقد اتبعت طرق مختلفة لتشغيل الجراجات الميكانيكية المعتمدة على المصاعد المتحركة أفقيا ورأسيا ومن أهم هذه الطرق طريقة بوزر Bowser system شكل (١) وشكل (١٠) وقد



شكل (١) طريقة بورزبيجون هول
Bowser Pigoonhole System



شكل (٢) طريقة فرتيايم Wertheim

طبقت الأول مرة بالولايات المتحدة عام ١٩٥١ ، وفى هذه الجراجات يوجد بئر ، للمصاعد يبلغ عرضه حوالى ٦٫٥٥ متر يمتد طوليا خلال المبنى كله وتفتح عليه أماكن الانتظار من الجانبين فى الأدوار العليا أما فى طابق الوصول فتقع صالات الاستقبال على أحد الجانبين الطوليين للبدء بينما تقع صالات التسليم على الجانب المقابل له ويبلغ عمق هذه الصالات طول سيارة واحدة أو سيارتين بحيث تتسع لصف أو صفين من السيارات .

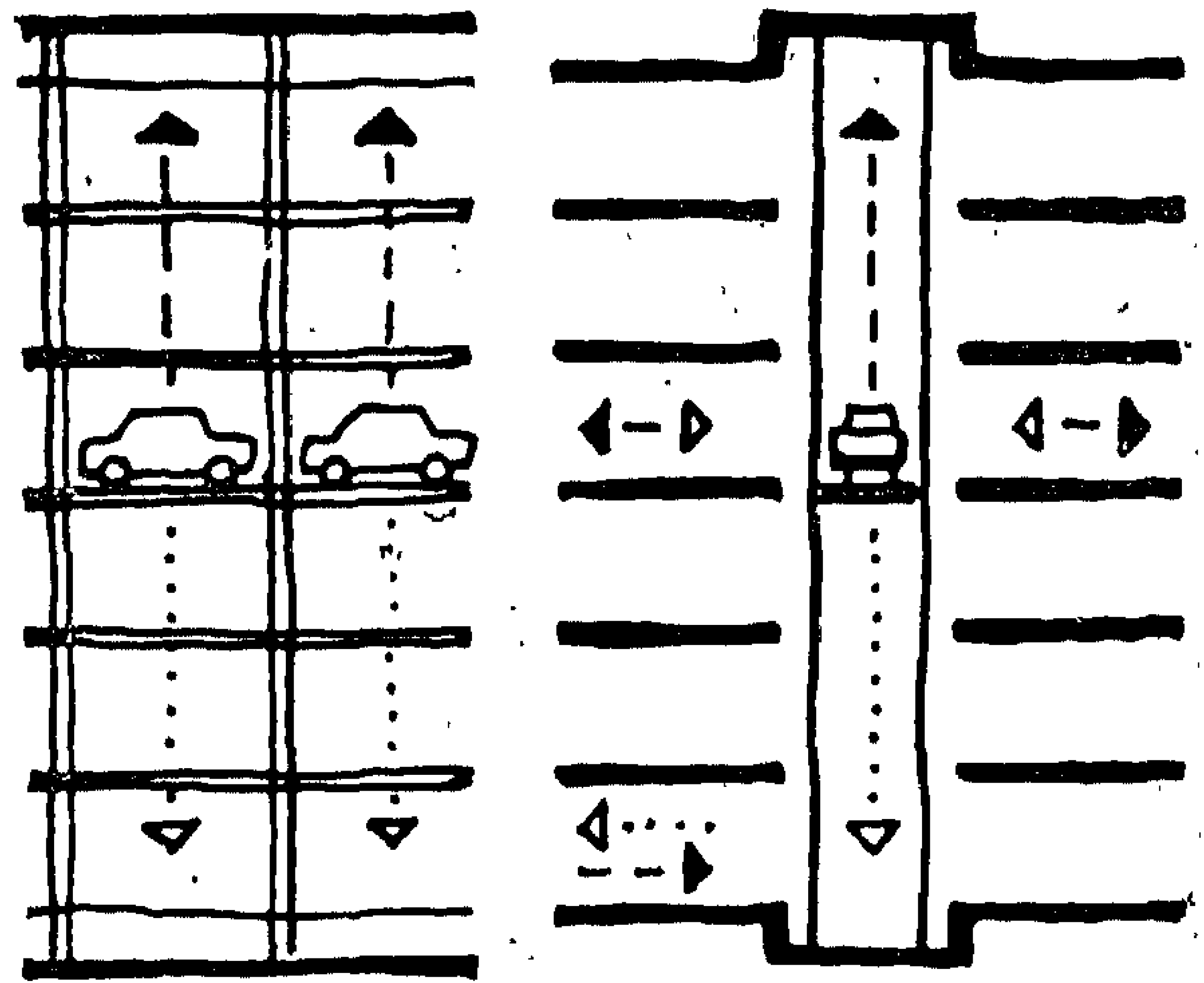
وتتحرك المصاعد رأسيا داخل أبراج هيكلية من الصلب أما الحركة الأفقية فتتم بتحريك الأبراج نفسها أفقيا فى الاتجاه الطولى لبئر المصاعد وذلك بتركيبها فى أوناش علوية على هيئة كبارى أعلى بدء المصعد أما الجزء الأسفل من الأبراج فيتحرك على دليل فى تجويف أسفل البئر ، ومن الناحية الانشائية فان تعليق الأبراج يساعد على امكانية تصميمها بقطاعات خفيفة الى حد كبير .

وتتراوح سعة الجراجات المصممة على طريقة بوزر بين ٢٢٥ر٦٥٠ سيارة ويلاحظ أنه فى حالة زيادة عدد السيارات عن الحد الأقصى لها تقل كفاءة تشغيلها ويكون من الضرورى توفير مساحة كبيرة لتخزين السيارات تمهيدا لنقلها الى الأماكن المخصصة لانتظارها بالأدوار العليا ، وفى الأمثلة التى تم تنفيذها روعى توفير مصعد لكل ١٢٥ سيارة تقريبا أما صالات الاستقبال فهى بواقع من ستة الى ثمانية صالات لكل مائة سيارة ولها مداخل مباشرة من الخارج .

وفى هذه الجراجات يقوم أحد العمال بقيادة السيارة من صالة الاستقبال الى داخل المصعد ثم من المصعد الى المكان المخصص لانتظار السيارة كما يتولى أحد العمال قيادة السيارة عند طلبها لنقلها من مكانها الى المصعد ويتحرك المصعد الى أسفل لتسليم السيارة الى صاحبها ، وفى بعض

الأنظمة الميكانيكية الأخرى المشابهة لطريقة بوزر يتم نقل السيارة بواسطة دافعة متحركة dolly تتحرك على عجلات من المطاط ويقوم بتشغيلها عامل مختص من مكانه داخل المصعد ومن الطرق التى يتم فيها استخدام الرافعة طريقة بيجون Pigeon Hole System وقد طبقت الأول مرة عام ١٩٥٠ بالولايات المتحدة وكذلك طريقة فرتهايم أوتوباركر Wertheim Autoparker شكل (٢) بالنمسا للمهندس المعمارى كارل شفانزر Karl Schwanzer وقد طبقت فى أحد مبانى الجراجات بفيينا عام ١٩٥٧ — ١٩٥٨ فى جراج يضم أربعة عشر طابقا منها ثلاثة بدرومات ويتسع لثلثمائة سيارة وتبلغ المساحة المخصصة للسيارة فى هذا المبنى ٢٢ر٨ مترا مربعا ويلاحظ أن أبراج المصاعد فى كل من الطريقتين الأخيرتين تتحرك أفقيا على قضبان فى تجويف أسفل بدء المصعد .

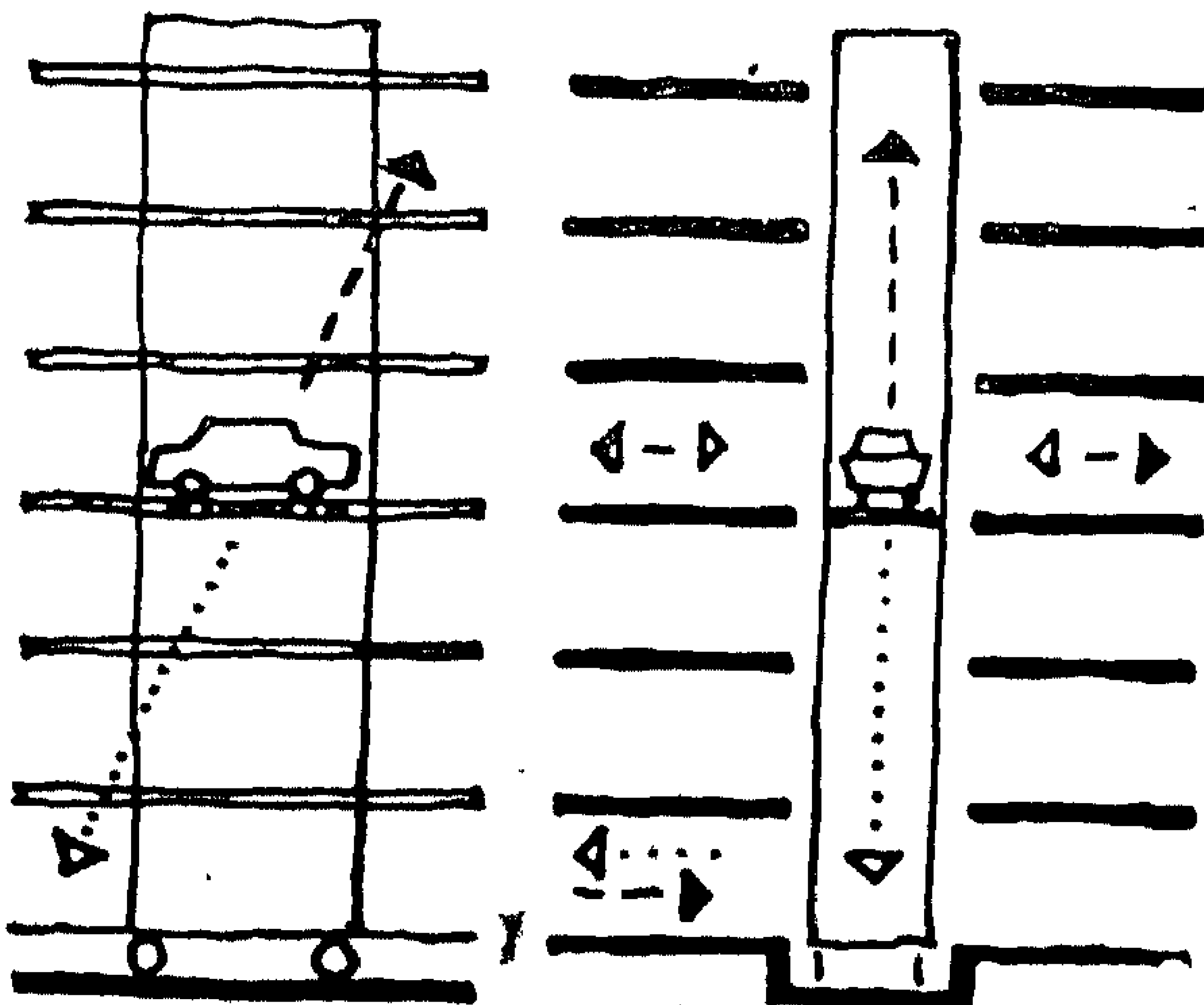
ومن الطرق التى يتم تشغيل الجراجات الميكانيكية فيها أوتوماتيكيا بالكامل طريقة زيدبارك Zidpark System شكل (٣) ويعتمد التصميم



شكل (٣) طريقة زيدبارك Zidpark

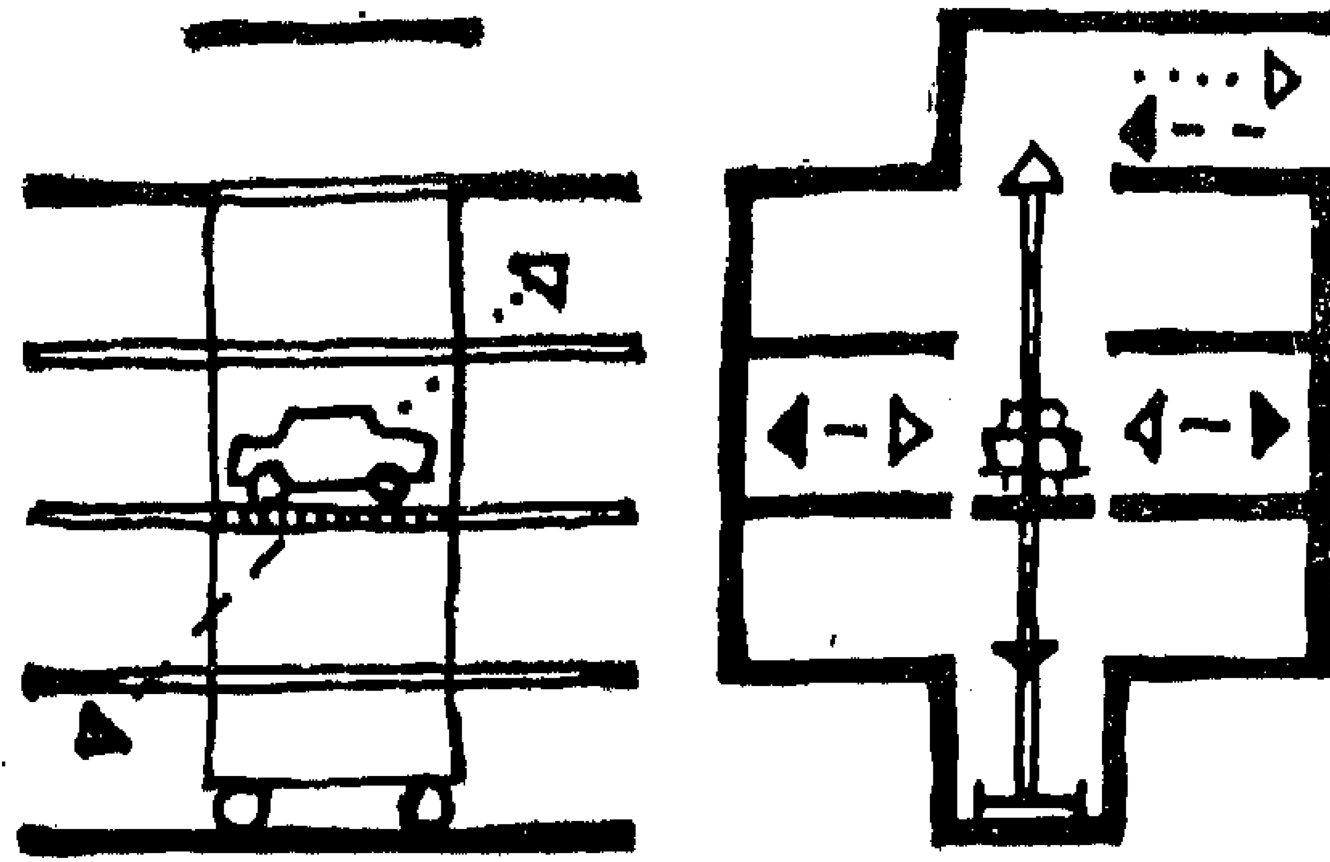
فيها على تجميع وحدات متماثلة تشمل كل وحدة مصعدا يتحرك رأسيا فقط وصالة للاستقبال وصالة للتسليم او صالة واحدة يتم فيها استقبال السيارة وتسليمها ثم مكانين للانتظار على كل من جانبى المصعد بكل دور ، وتكون السيارة فى هذه الطريقة موازية لبئر المصعد وليست عمودية عليه كما فى الطرق السابقة وتتم عملية ادخالها الى المصعد أو خروجها منه بتحريكها جانبيا بواسطة سيور ناقلة تركب على أرضية المصعد وكذلك على أرضية صالات التسليم والاستقبال وأماكن الانتظار وهى تتكون من مجموعتين من المواسير الصلب مجمعة على هيئة سيور واحدة منها للعجلات الأمامية والثانية للعجلات الخلفية وقد صممت كل مجموعة بعرض كاف بحيث تسمح المسافة بين المجموعتين بنقل السيارات باختلاف الأطوال بين عجلاتها الأمامية والخلفية ، وتتم عملية الانتظار أوتوماتيكيا بالكامل من لوحة للكنترول اما بواسطة أحد العمال او العميل نفسه وتقل فى هذا النوع من الجراجات المساحة المخصصة للانتظار عنها فى الأمثلة السابقة اذ تبلغ حوالى ٢٠ر١٢ — ٣٠ر١٥ مترا مسطحا للسيارة ويمكن استخدام مصعد لكل ٢٤ — ٦٠ سيارة لجراج من ستة الى خمسة عشر طابقا ، وقد طبقت هذه الطريقة فى أحد الجراجات بلندن عام ١٩٦١ شكل (١١) قام بتصميمه المهندس المعمارى ادموند ويلفورد C. Edmund Wilford وتبلغ سعته ٤٦٤ سيارة وهو مبنى من الصلب وقد وافقت السلطات على عدم ضرورة استعمال خرسانة لحماية المنشأ الصلب من الحريق كما تقضى بذلك اللوائح حيث أن تشغيل الجراج يتم بالكامل دون الحاجة الى ادارة ماكينات السيارات الأمر الذى يقلل من أخطار الحريق الى حد كبير وحتى أرضيات أدوار الانتظار نفذت من الواح من الصلب المضلع وروعى عمل المجارى اللازمة لصرف الماء المتخلف من غسيل السيارات والزيوت .

وقد قامت شركة أوتيس للمصاعد Otis بالاشتراك مع مؤسسة سبيدبارك Speed Parc Inc. شكل (٤) بتطوير طريقة لتشغيل الجراجات أوتوماتيكيا بالكامل تعتمد الفكرة فيها على وجود صالة واحدة لاستقبال السيارة أو تسليمها بالدور الأرضى (دور الوصول عادة) تقع بين بئرين للمصاعد يمتدان بطول المبنى وخلال الأدوار كلها وتتحرك المصاعد فى هذين البئرين داخل أبراج تنزلق أفقيا على قضبان مركبة فى تجويف أسفل بئر المصعد وتقع أماكن الانتظار

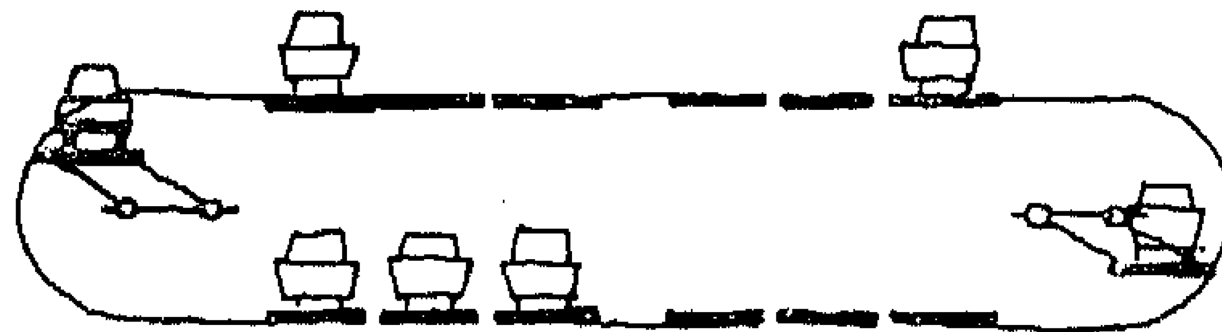


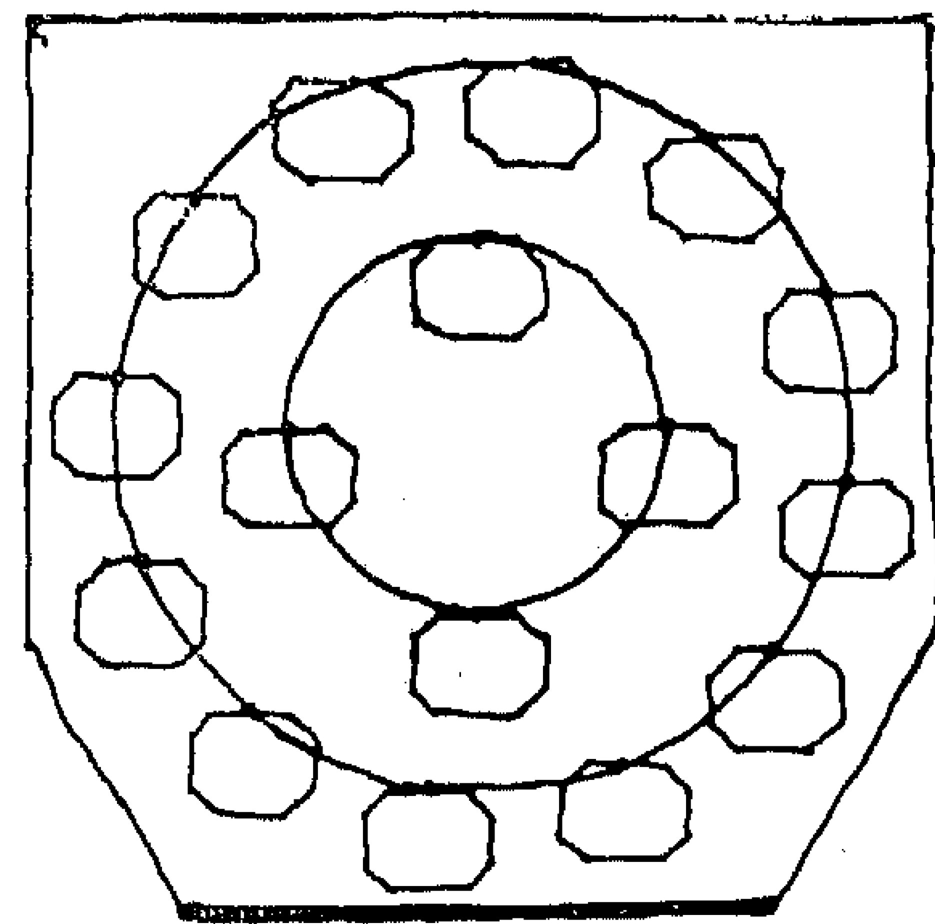
شكل (٤) سبيدبارك Speed Park

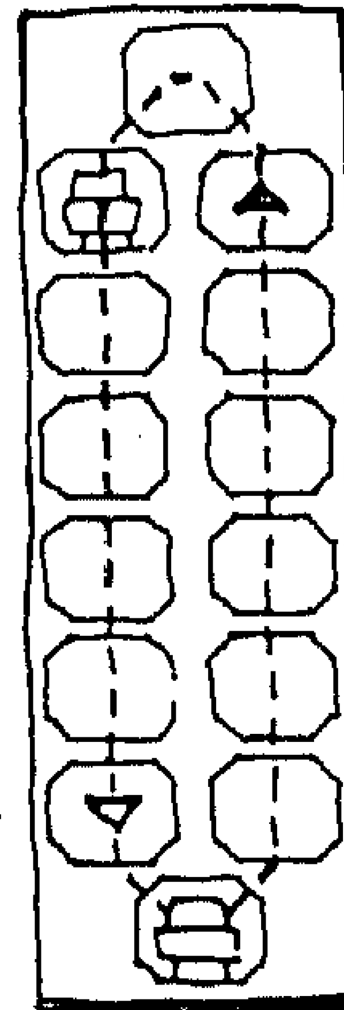
بالأدوار العليا على كل من الجانبين الطوليين لبئرى المصاعد ، وتأخذ السيارات فى هذه الطريقة سواء عند دخولها أو خروجها وكذلك وهى واقفة بأماكن الانتظار المخصصة لها وضعا موازيا لبئر المصعد كما فى الطريقة السابق شرحها وتنتقل السيارة الى داخل المصعد أو خارجه فى جميع الأحوال بواسطة أذرع مركبة على أرضية المصعد وتخرج منه أوتوماتيكيا الى الخارج أسفل عجلات السيارة لتحملها وتعود بها الى داخل المصعد أو العكس ولتحقيق هذه العملية صممت الأرضية التى تقف عليها السيارة فى الأماكن المختلفة على هيئة أضلع متوازية فى اتجاه عمودى على بئر المصعد بحيث يمكن ان تدخل بينها أذرع المصعد لتحمل السيارة الى أعلا ثم الى داخل المصعد .

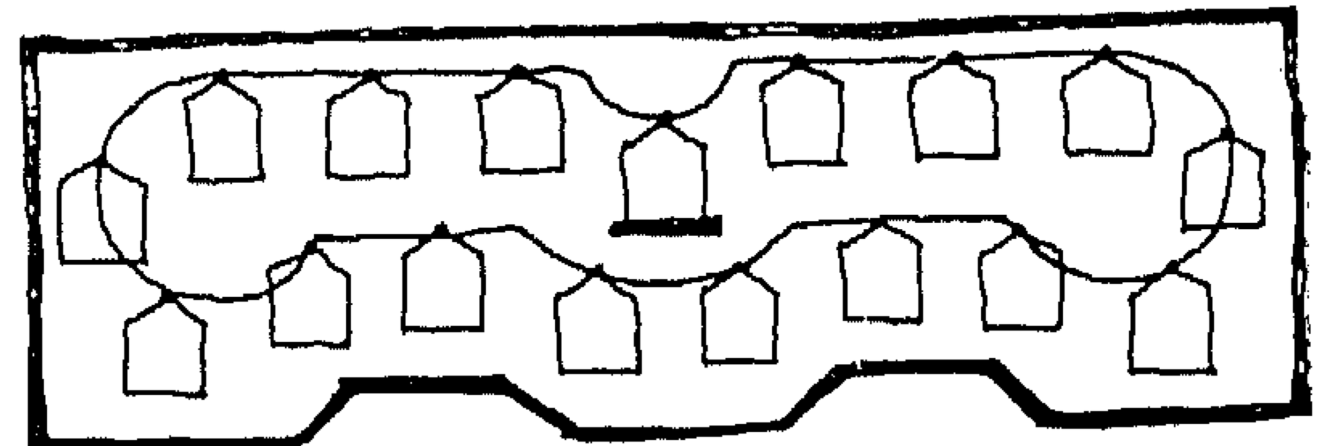


شكل (٥) طريقة باركال لجراجات البدرومات Parkallu









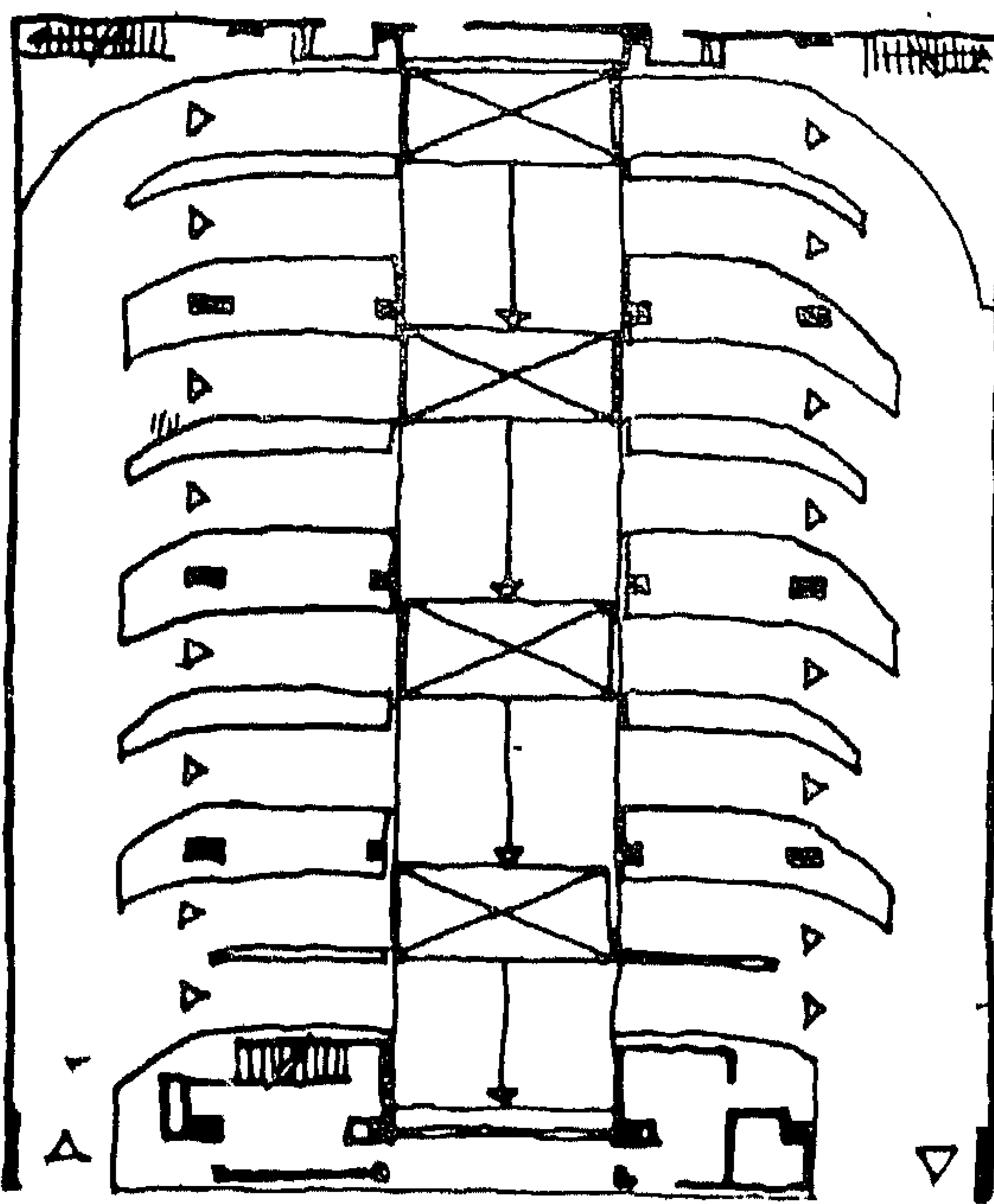
(٦) ، (٧) ، (٨) ، (٩)

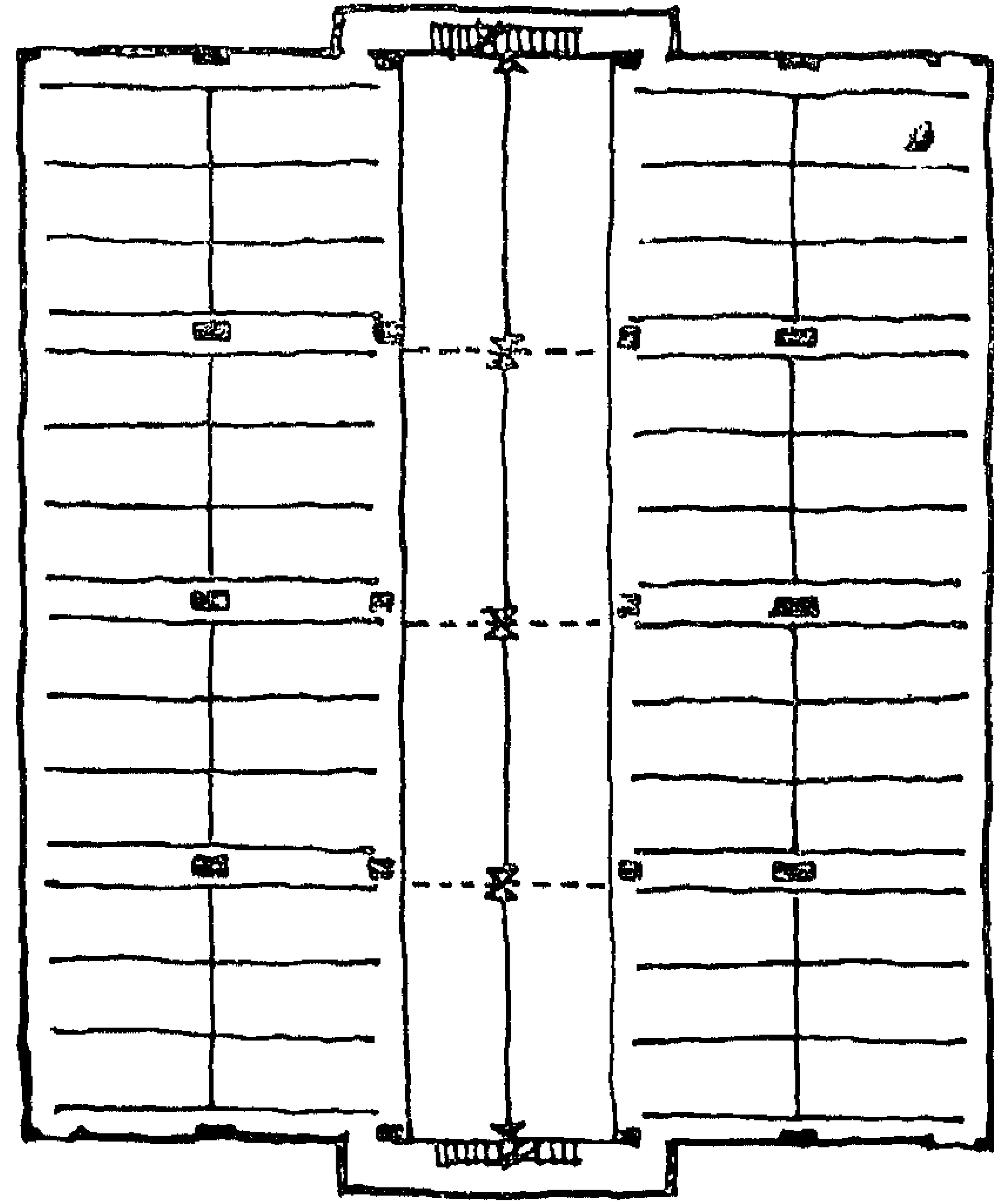
طرق استعمال أماكن الانتظار المتحركة باستخدام السيور المتحركة او العجلات

وفى طريقة Speed Parc تدار العملية كلها من مكان مركزى ويمكن لشخص بمفرده ادارة جراج مصمم بهذه الطريقة ويسع حتى خمسمائة سيارة ، وقد قام المهندسان المعماريان فرانسيسكو وجاكوبس Francisco and Jacobus بتطبيق هذه الفكرة فى جراج بمدينة نيويورك شكل (١٢) يسع ٢٧٠ سيارة ويتكون من ثمانية أدوار ارتفاع كل منها ٢٫٣٨ مترا وقد تم انشاؤه عام ١٩٦١ ، ويقوم شخص واحد بتشغيل هذا الجراج بواسطة مجموعة من الأزرار الضاغطة ينقل بها السيارات الى أماكن الانتظار المخصصة لها أو يسترجعها وتحسب لها كذلك الرسوم المقررة للانتظار الذى يقوم هو نفسه بجمعها .

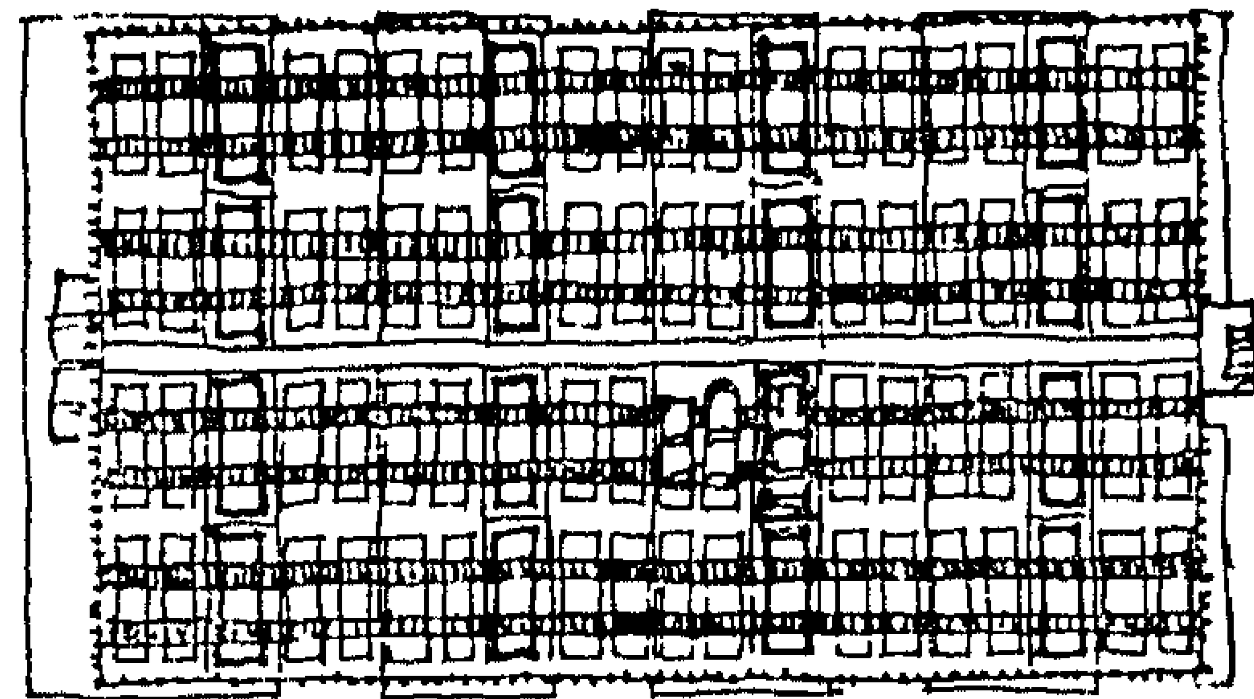
الجراجات ذات المنحدرات Ramp Garages

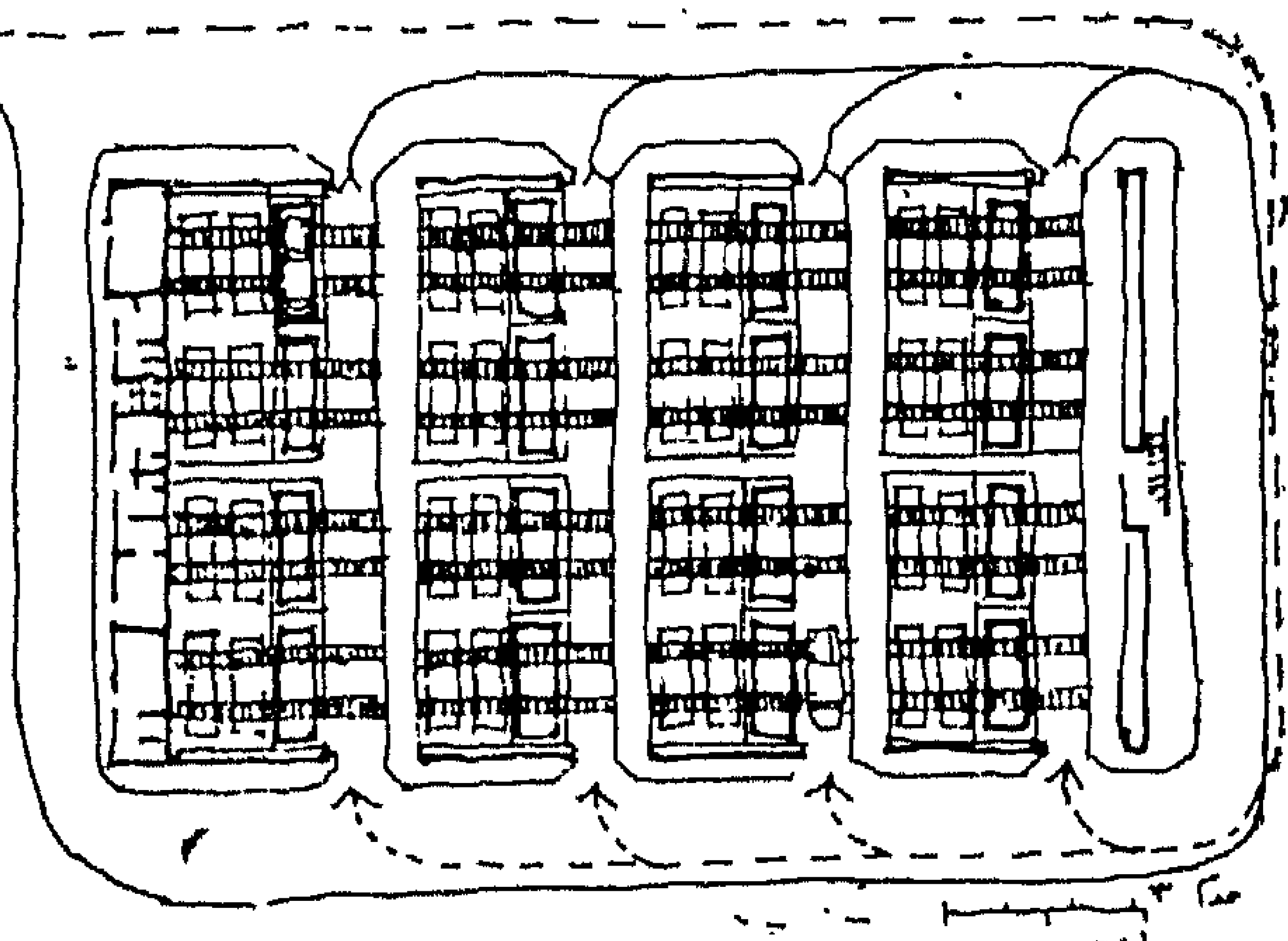
يعتمد تشغيل هذا النوع من الجراجات على قيادة السيارة الى مكان الانتظار المخصص لها بالأدوار المختلفة وتجرى السيارة على مستوى مائل وهو « المنحدر » ويمكن تقسيم المنحدرات





شكل (١٠) مبنى جراجات بمدينة دنفر بولاية كولورادو ١٩٥٤ سعة ٤٨٠ طريقة بوزر Bowser system

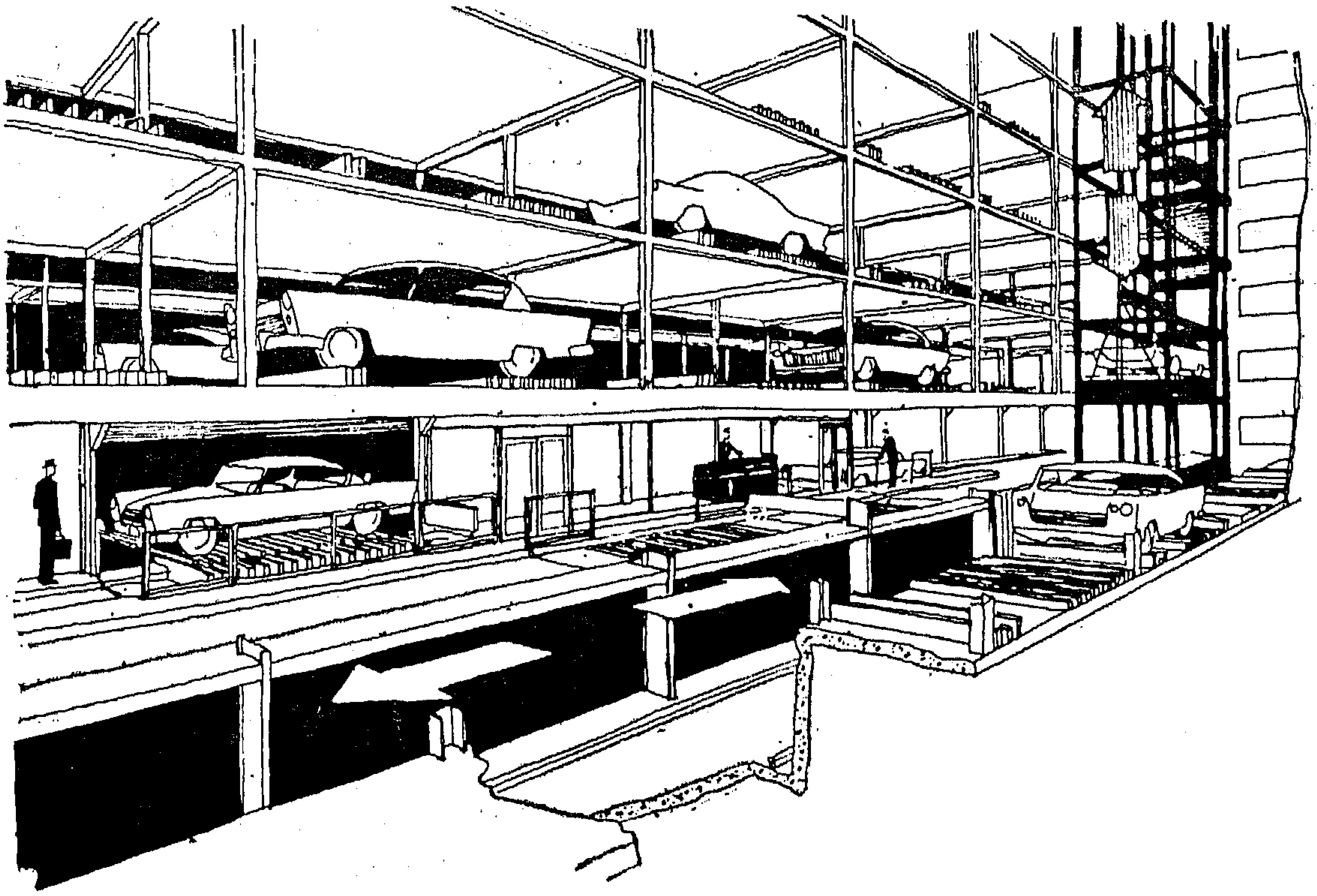




شكل (١١) مبنى جراجات بمدينة لندن ١٩٦١
المهندس ادموند وبلفورد — سعة ٤٦٤ سيارة — طريقة زيد بارك Zidpark

المستعملة بصفة عامة الى قسمين أساسيين : المنحدرات المستقيمة شكل (١٣ — ١٨) والمنحدرات الحلزونية ، وفى كلا النوعين يتحتم ضمانا للامان وسرعة التشغيل عمل منحدر للصعود وآخر للهبوط منفصلين عن بعضهما وفى الأحوال التى يتحتم فيها عمل منحدر واحد للحركتين معا فانه يلزم فصل الاتجاهين عن بعضهما كأقل احتياط ممكن ، وفى بعض الأمثلة التى تم تنفيذها ترتبط أدوار الانتظار ببعضها بمنحدرات تقع خارجا عن هذه الأدوار ولكن هذا الاتجاه فى التصميم تنتج عنه حلولا غير اقتصادية اذ يتطلب مسطحا كبيرا نسبيا من الأدوار بالنسبة للمسطح اللازم للسيارة الواحدة .

وتقل المساحة المطلوبة للسيارة الواحدة فى هذه الجراجات عند تصميمها بحيث يتم جزء من حركة السيارة الى اعلا أو الى اسفل على ارضية طابق الانتظار نفسه كما يمكن استعمال طوابق الانتظار نفسها كمنحدرات اذ صممت على شكل مستويات مائلة وبذلك نحصل على حلول اقتصادية الى حد كبير شكل (١٧) وشكل (١٨) .



شكل (١٢) مبنى جراجات بمدينة نيو يورك ١٩٦١ للمهندسان فرانسيسكو وجاكوس سعة ٢٧٠ سيارة طريقة
سبيدبارك Spead Park

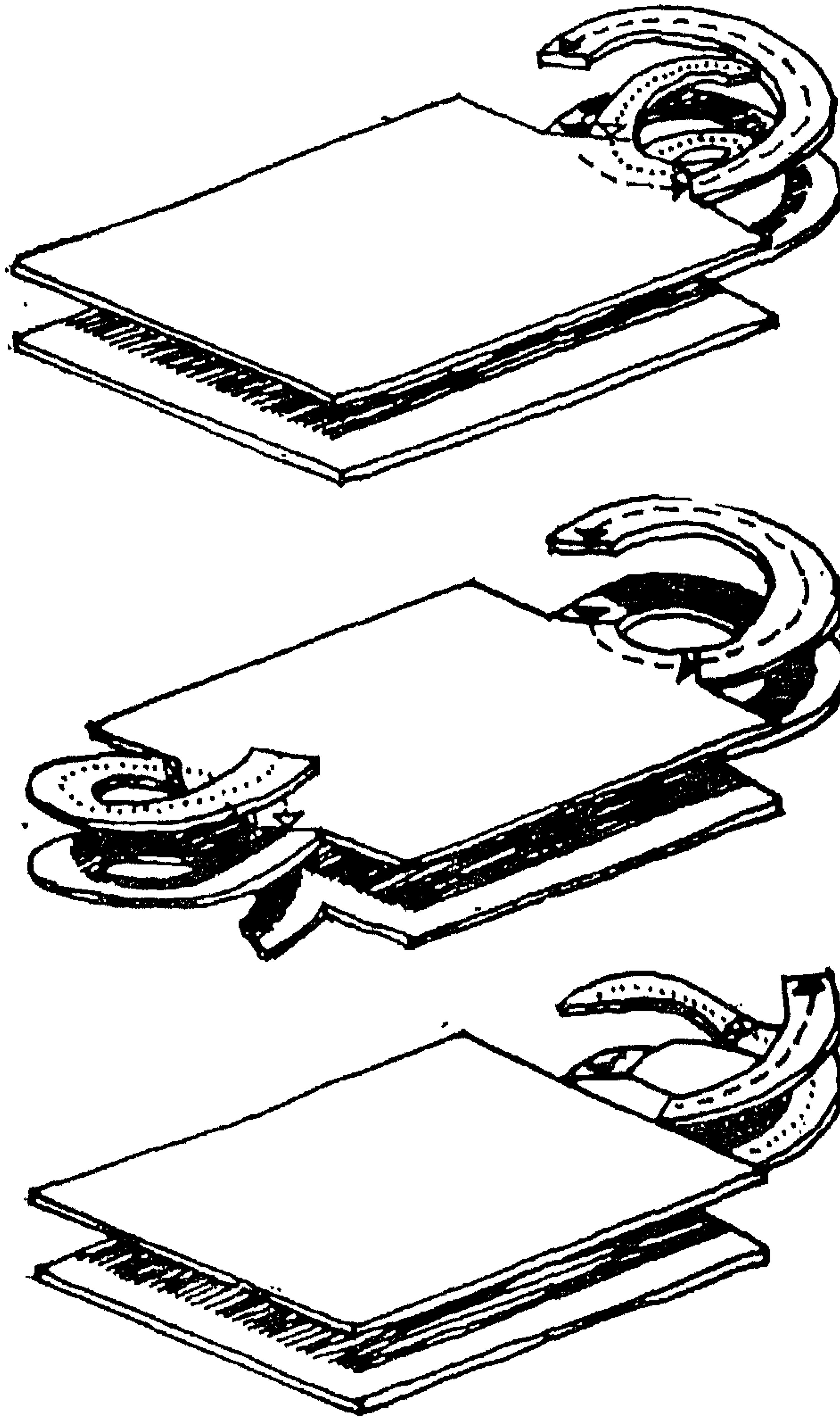
الاشكال ١٣ - ١٤ - ١٥ - ١٦ - ١٧ - ١٨ - استعمال المنحدرات المستقيمة

ويجب أن يراعى فى تصميم هذه الجراجات أن يكون المرور فى طوابق الانتظار فى اتجاه واحد ويتحقق ذلك بسهولة فى تلك الجراجات التى تنفصل فيها المنحدرات عن طوابق الانتظار وتقع خارجا عنه كذلك فى الجراجات ذات المنحدرات الحلزونية والتى ينفصل فيها المنحدر الحلزونى للصعود عن منحدر الهبوط وتبلغ أقل مساحة من الأرض لتصميم جراج من هذا النوع حوالى ٣١٫٠٠ × ٣١ مترا .

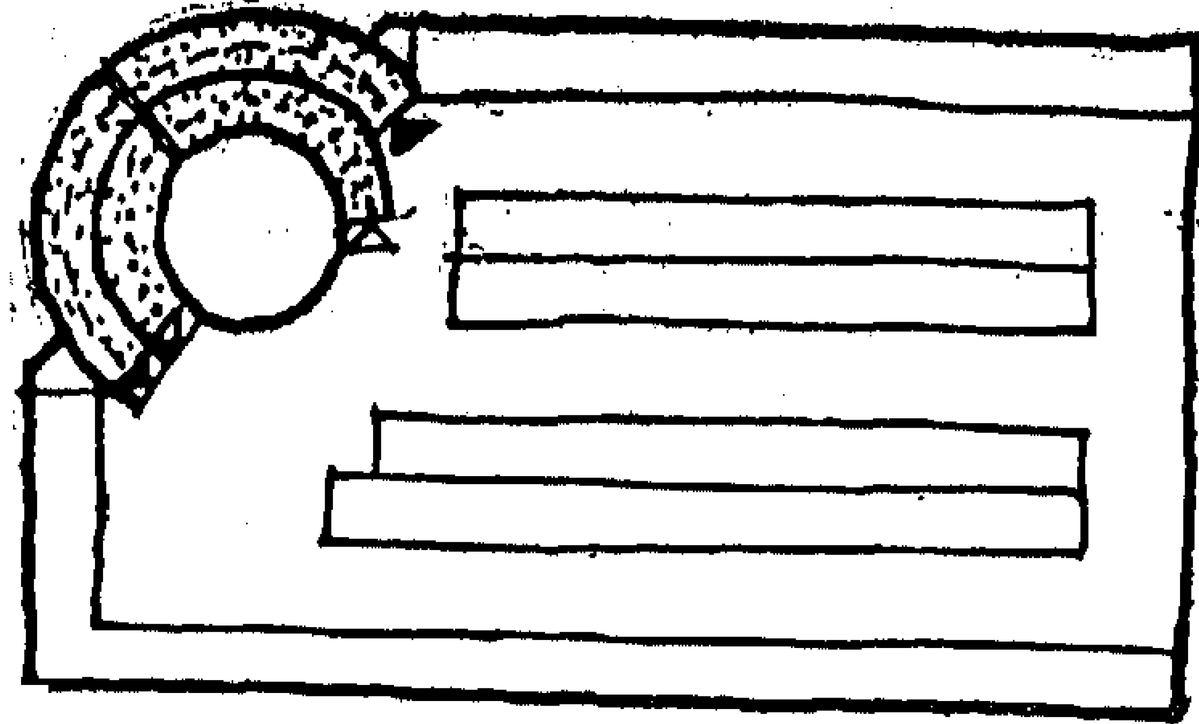
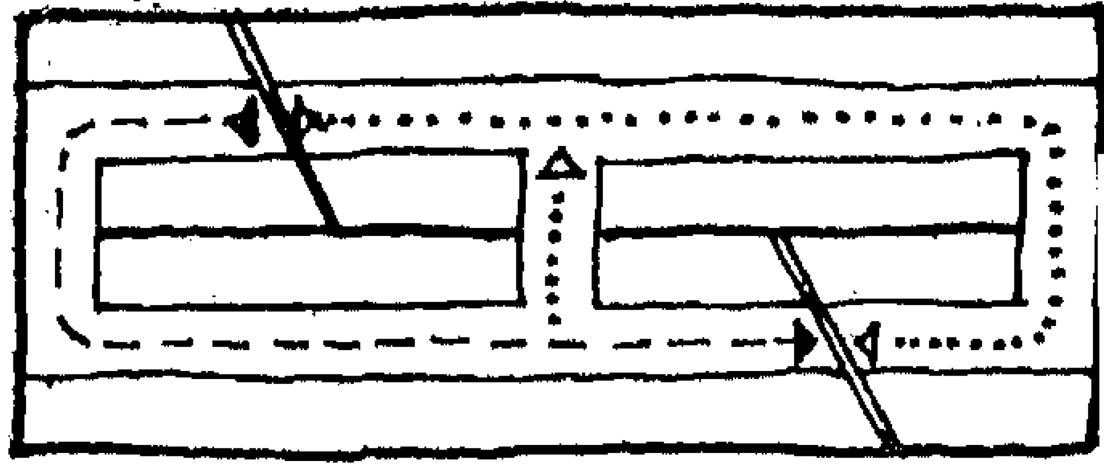
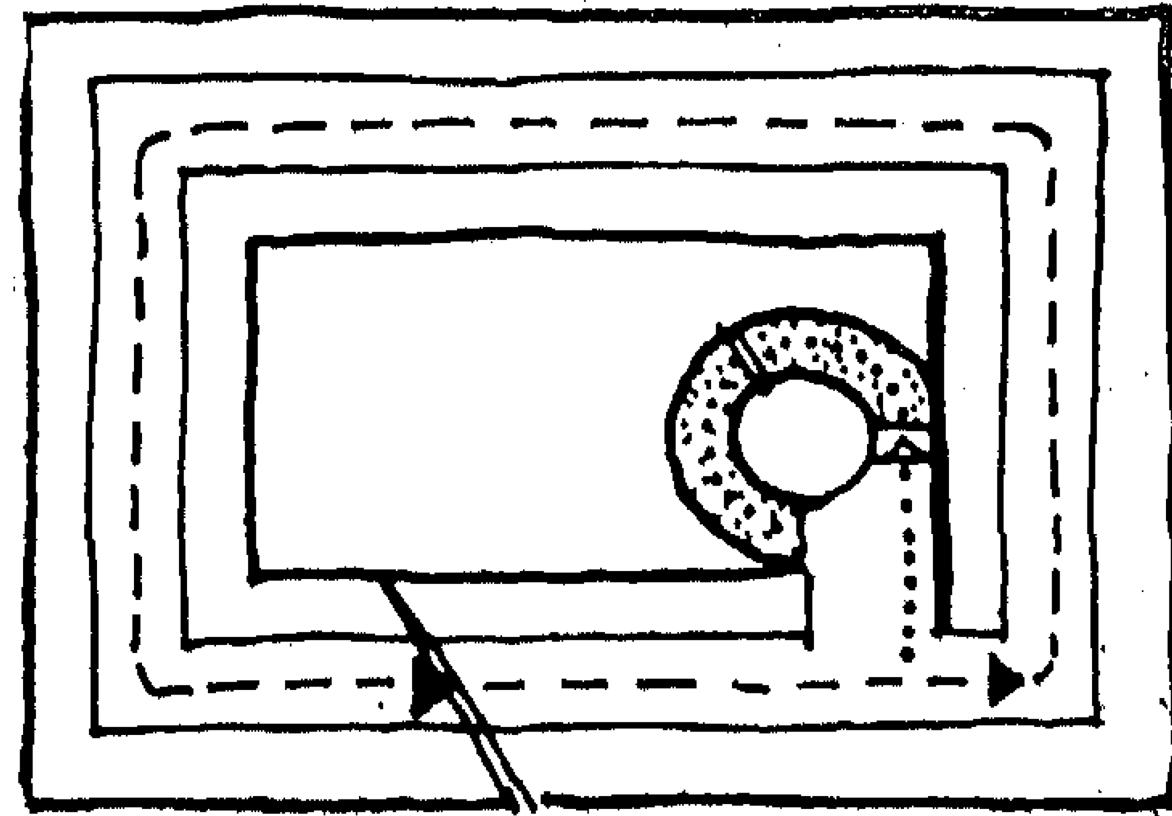
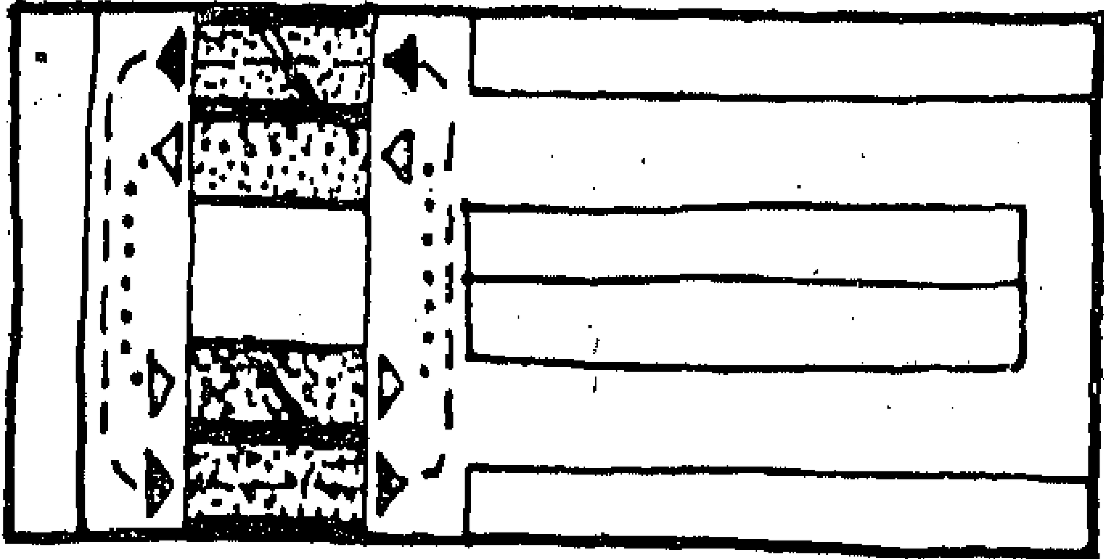
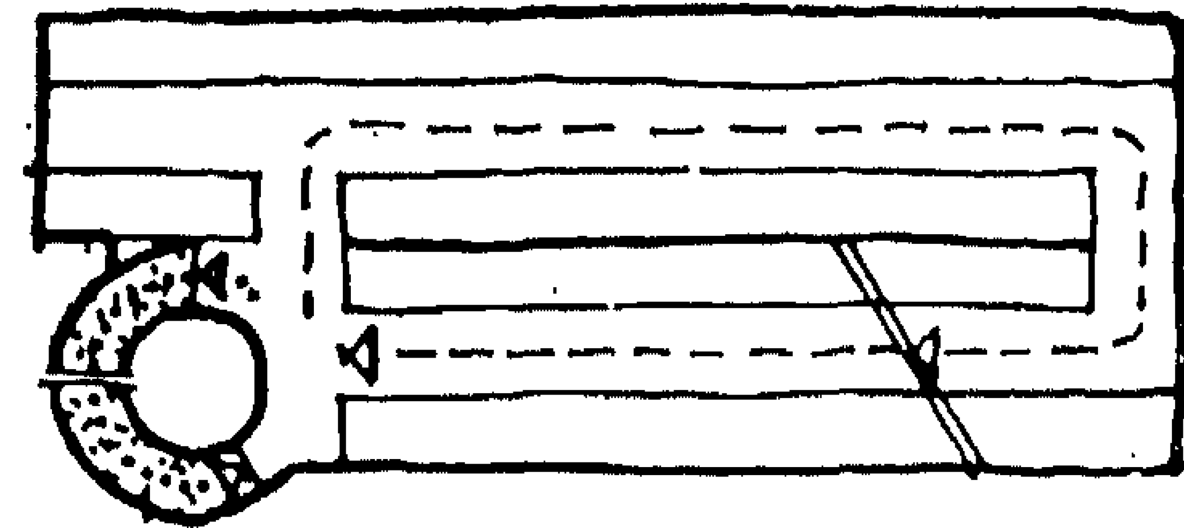
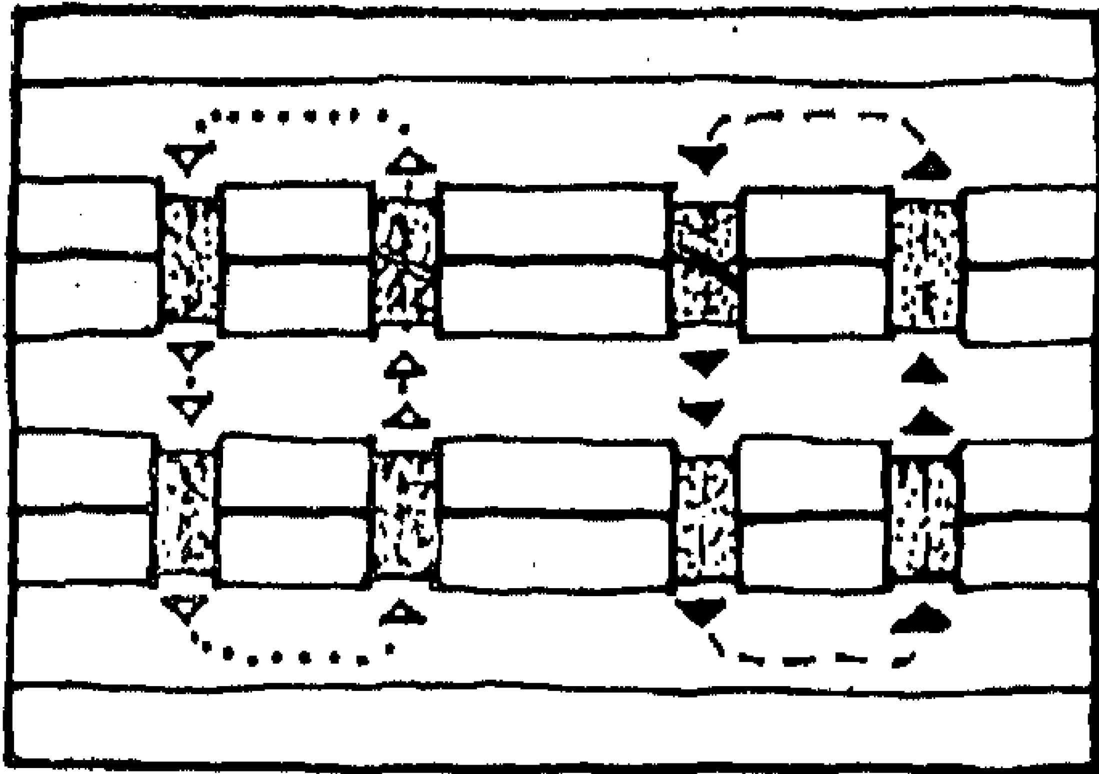
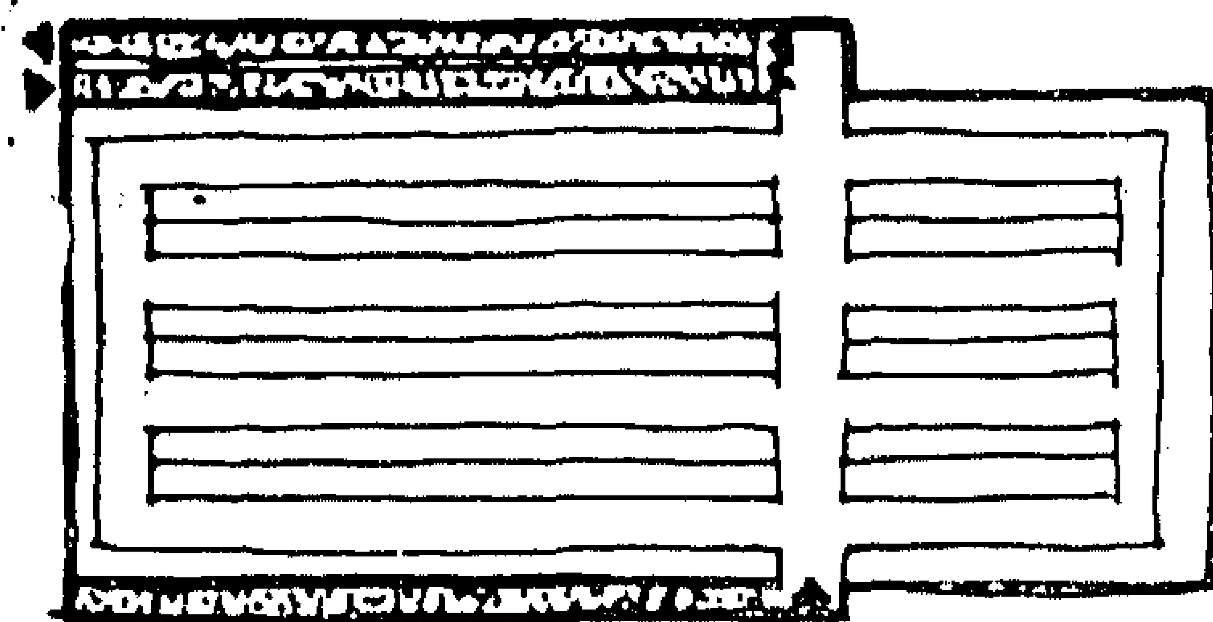
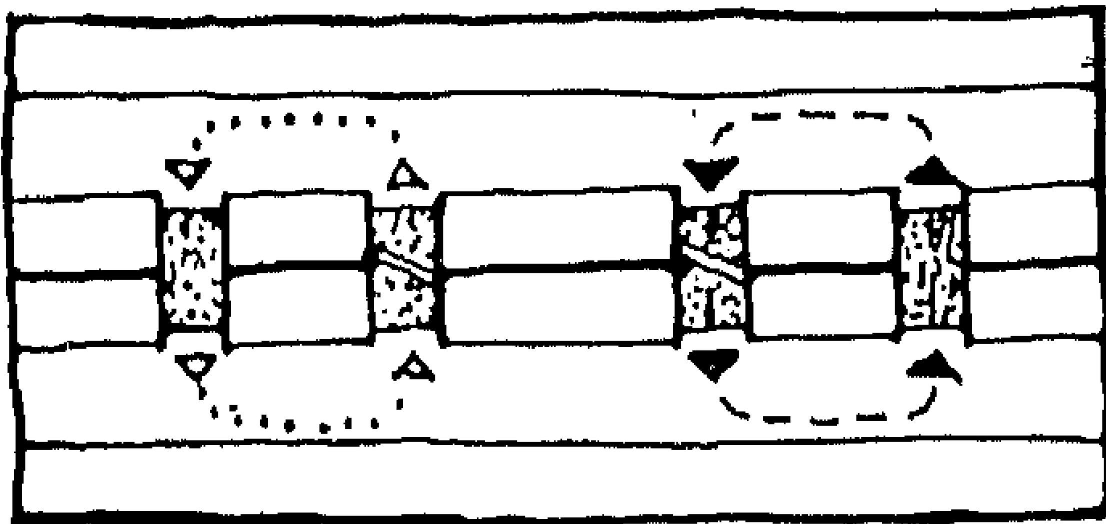
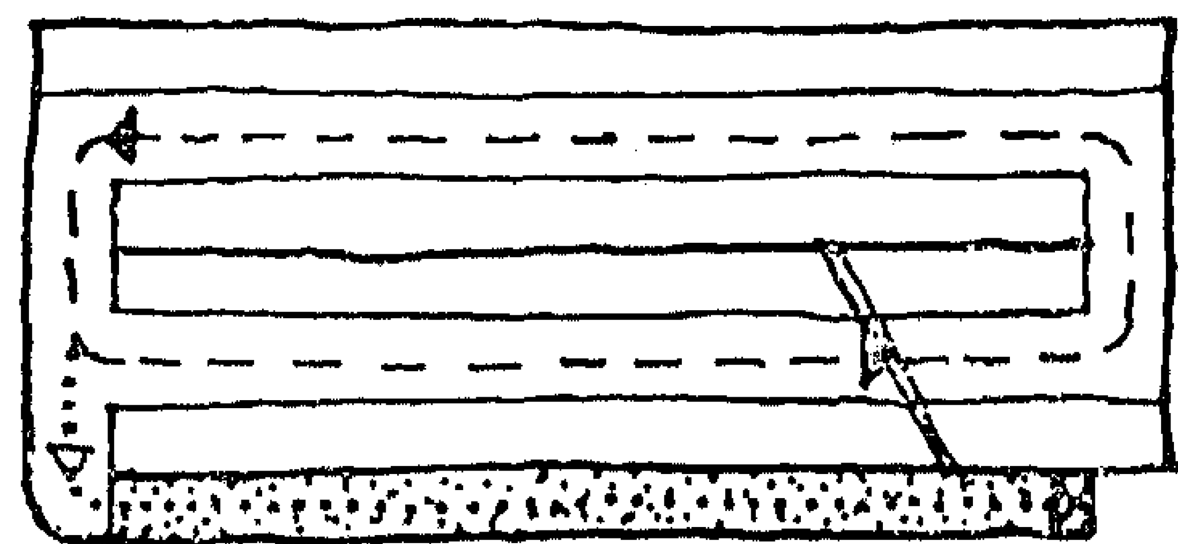
ونظرا لسهولة انشاء هذا النوع من الجراجات بالمقارنة بالجراجات الميكانيكية وكذلك لقلة التكاليف الانشائية فضلا عن مصاريف الصيانة فانه قد عم استعمالها وتم تنفيذ عدد كبير منها فى الولايات المتحدة وفى كثير من البلاد الأوربية استعملت فيها المنحدرات بطرق مختلفة أشكال (٢٢ — ٣٠) فقد تم تنفيذ جراجات بمنحدرات مستقيمة أو حلزونية بين طوابق الانتظار المختلفة وفى بعض الأمثلة استعملت منحدرات تصل بين طوابق على مستويات متوسطة بينها Split Levels كما نجد أمثلة أخرى طبقت فيها فكرة استعمال الطوابق المائلة لانتظار العربات وذلك توفيرا للمساحة التى تخصص لنحدرات الصعود والهبوط .

وتتم قيادة السيارة الى مكان الانتظار اما عن طريق صاحبها نفسه أو يقوم بذلك عامل مختص ويمكن تحقيق وفر كبير فى المساحة المخصصة للسيارة فى الحالة الثانية نظرا لامكانية رص السيارات رصا متقاربا يتقنه العامل المختص ويفضل أصحاب السيارات هذه الوسيلة فى الولايات المتحدة بينما لا تجد قبولا فى الدول الأوربية حيث يفضل الناس عامة قيادة سياراتهم بأنفسهم فضلا عن اختلاف أنواع السيارات اختلافا كبيرا مما يشكل صعوبة لعمال القيادة .

ويجب عن تصميم هذه الجراجات تزويدها بالأماكن الكافية عند المداخل والمخارج حتى تقف فيها العربات انتظارا لأخذ دورها للدخول أو الخروج خاصة فى الأوقات الحرجة التى تزيد فيها عدد السيارات زيادة ملحوظة وتتراكم بسببها السيارات .



الاشكال ١٩ — ٢٠ — ٢١ — استعمال المنحدرات الحلزونية

(٢٢ ـ ٣٠)

تطبيقات مختلفة لاستعمال المنحدرات.

kept by the Department of Health & Social Security and which is built up and maintained on the basis of manufacturers quoting for various components against laid-down performance specifications. This data base, like the activity data base, is being updated and expanded continually as both medical function and building technology advances.

The fully coded drawings are digitised into the computer and hard copy can be retrieved for production purposes.

Similar developments are in train at all stages of the engineering design in order that production packages will be complete for the first Harness hospital which starts on site in the Summer of 1974.

This paper cannot describ exhaustively all the work of a large number of people over a period of some five years within a health building programme of some £300m The intention is to paint the picture with a rather broad brush and to hope that the ideas contained within it will intrigue hospital designers to the extent that they may wish to know more.

Howard Goodman
Raymond Moss } Architects



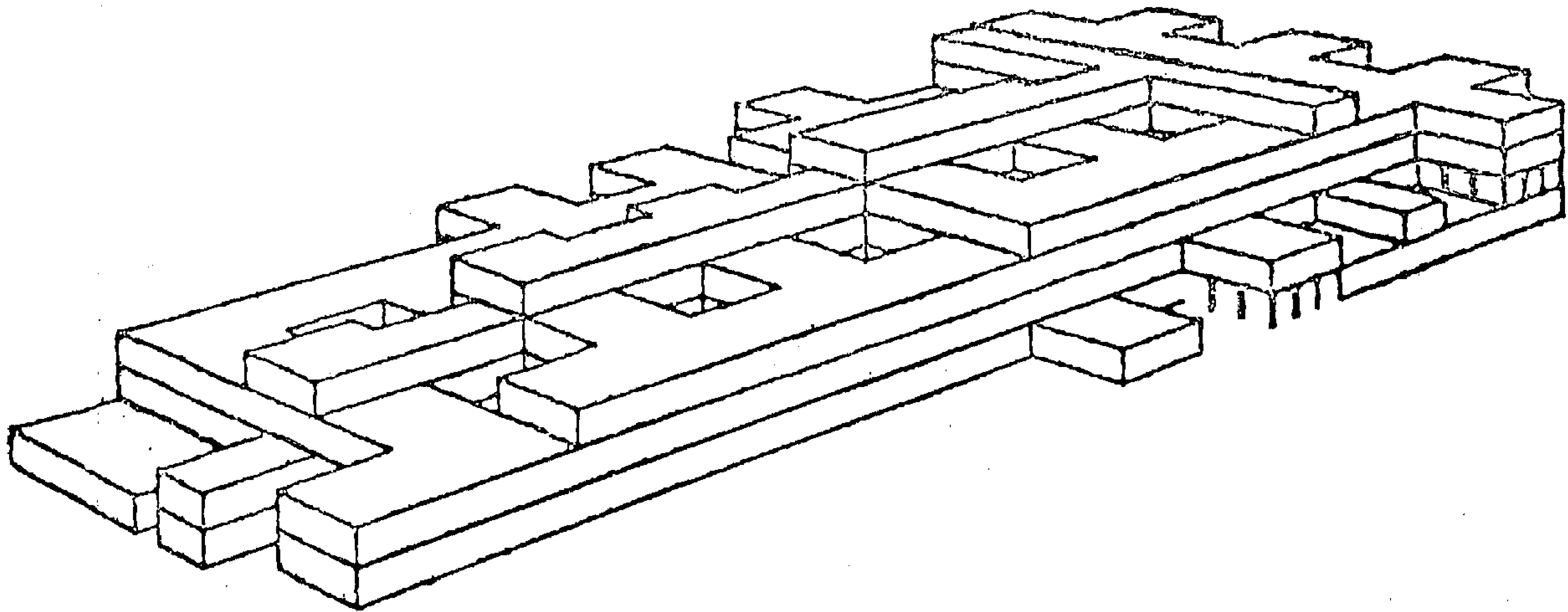


FIGURE 6

areas namely, activity data, manufacturers' data, and the computerisation of production material.

Operational policies for the whole hospital and the departments within it are the starting point for any project and in the standards and systems programme these documents have been produced to a common format which includes a schedule of accommodation and a line diagram of the standard department. Individual spaces are described fully, including functional and environmental aspects on room data sheets (A sheets). On these same sheets, codes are given which refer to the individual items of equipment required to fit the space out. The equipment requirements or activity units, as they have become known, are drawn in both plan and elevation on Activity Unit Data Sheets (B sheets), for which the computer holds a steadily growing index. Whole room assemblies are shown to 1/50th scale plan and wall elevations on what are referred to as 'C sheets'. 'D sheets' give the activity unit code as reference together with the quantity, size, cost, and manufacturers data base reference for the individual items.

'B sheets' are coded to a nationally agreed system and can be used therefore by any hospital authority for designing, euiping, and commissioning a new building, whether it is Harness or not. It is the activity unit which provides the continuous thread throughout the sequence of Harness hospital planning tasks, from briefing to evaluation.

● As input data then, design teams have agreed policies and schedules of accommodation, an activity unit index, a set of data sheets, and, in the event of them generating new material, a set of blank proformas which will subsequently be stored on completion in the activity data base. The design team will output co-ordinated A, B, C & D sheets and 1/50th scale loaded room layouts which have been prepared within the conventional and dimensional constraints of the Harness programme but which still require to be converted into production material. Teams who choose a standard solution will, of course, be able to draw on completed production packages.

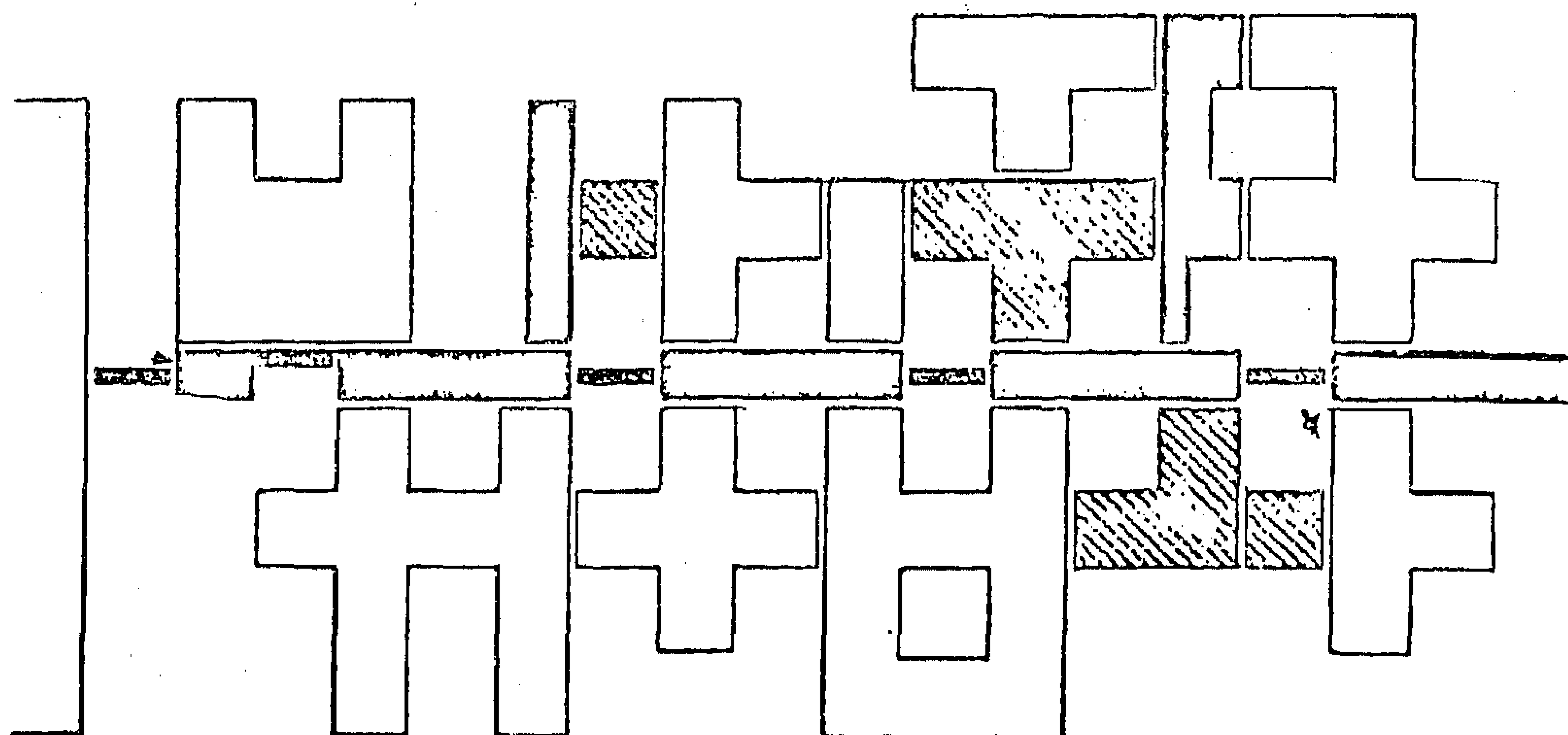
Conversion of the design material into the production package calls on the manufacturers' data base from which are drawn internal subdivisions, finishes, fittings, and so on, to match the stated performance requirements. The manufacturers' data base is a national "catalogue"

As a design aid, plastic profile pieces in various colours denoting different departments have been produced, which enable multiprofessional teams to undertake planning exercises. At such exercises it has been discovered that, providing the requirements of the hospital are set down, planning teams can produce sophisticated development control plans on contoured models in a period of a week. (FIGURE 5). The application of Harness standard departments, together with the use of the master grid and accompanying disciplines has facilitated the development of a number of computer aids. The most advanced of these, which uses an area association matrix, prints out development control plans either generatively or evaluatively and perspectives. (FIGURE 6). The aim of these programmes in evaluating and assembling development control plans is to increase the efficiency of Harness still further. This is done by providing the means to compare and evaluate alternative plans very rapidly by producing accurate statements of their cost and performance in relation to certain key criteria. At the present time, evaluative programmes are available to analyse circulation, structure and cladding, site works, effective site cover, day lighting, heating, and visual appearance. Other computer design aids are at various stages of development and one of these which generates and evaluates internal room arrangements, allows planning teams to interact with a visual display unit while planning a particular department.

● Developments in the briefing and production sub-system focus mainly on three



Figure 5



Floor level layout composed of:- FIGURE 4

Standard departments

Special accommodation

Harness Zone



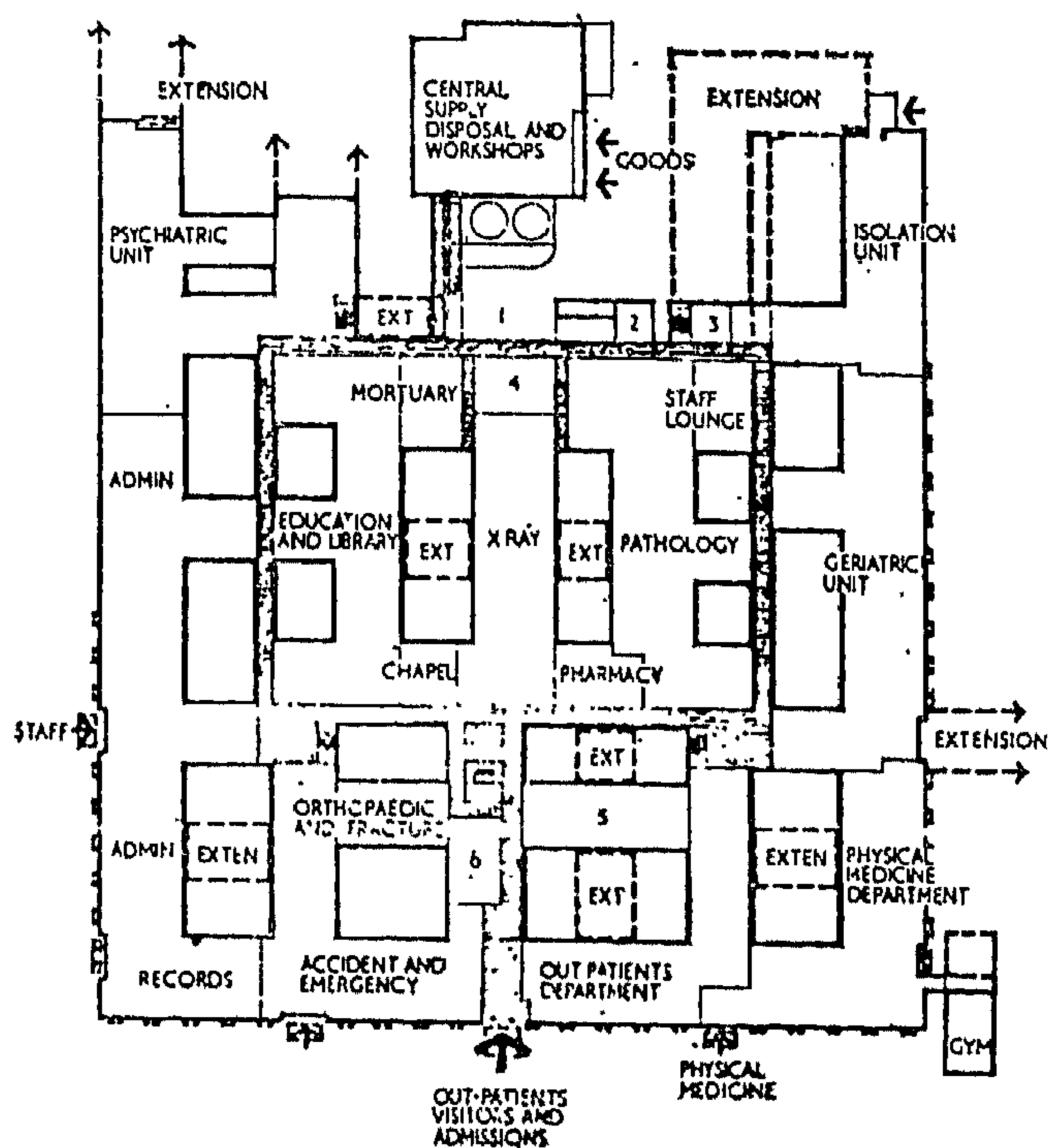
depending on size, while still allowing individual departments to be placed beside, below, or opposite one another. To maintain maximum interchangeability of departments and hence a wider range of development control plans, it was decide that all vertical transit media should be placed outside the standard departments. Further, a number of generic hospital shapes were identified, these being:-

X H T

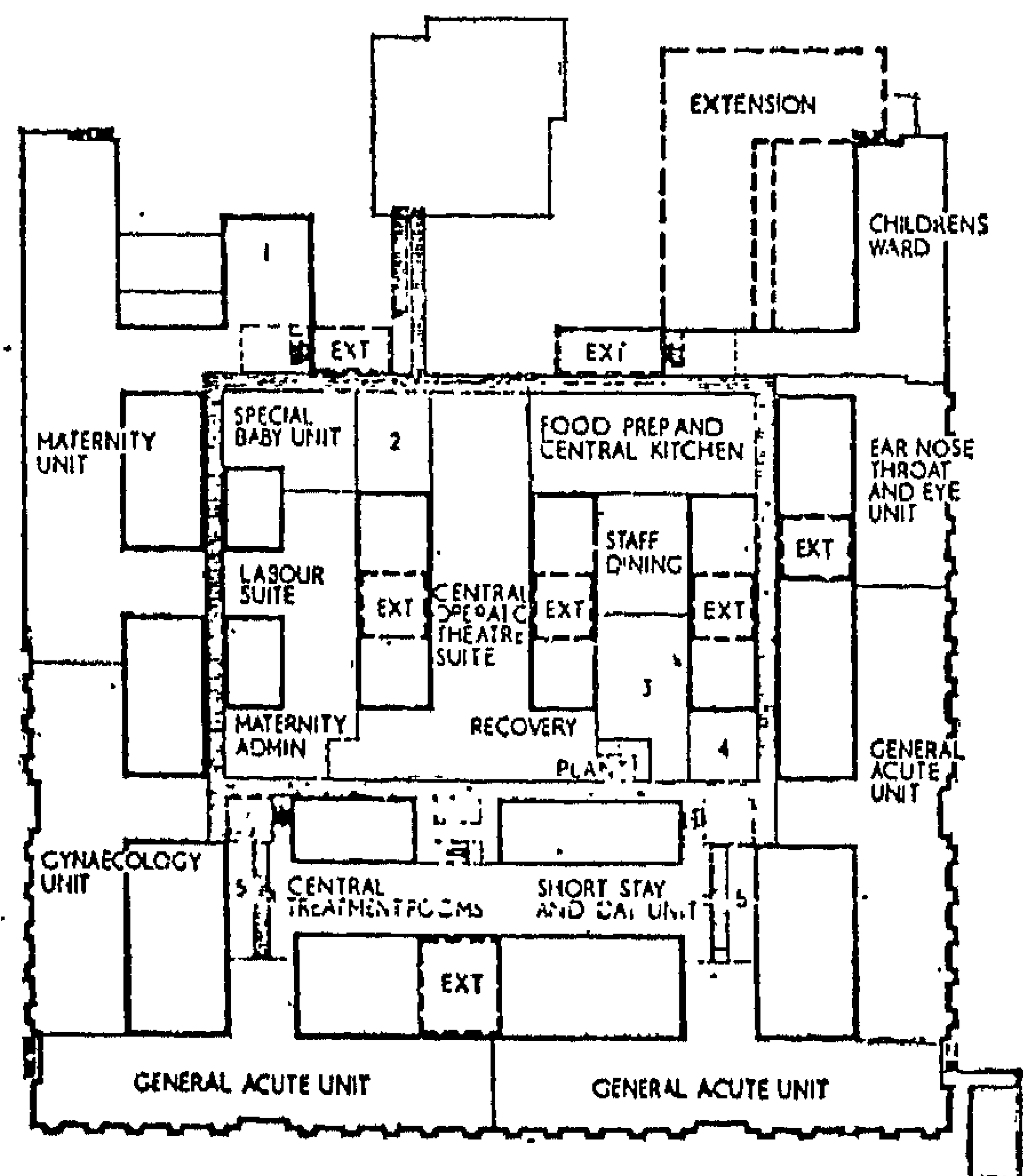
In order to bind the departments together into these various shapes and to provide the medium through which people, things, ideas, and energy could be distributed, both vertically and horizontally, the concept of a non-standard multi-functional corridor or communications network was evolved. This corridor, or zone, which holds the whole hospital together was code named 'The Harness' and subsequently hospitals designed using this system have become known as 'Harness Hospitals'. Additionally and for logistical, structural and environmental reasons, a height limit of four floors was established.

● Harness hospitals then comprise three basic components : a) standard accommodation in the form of pre-designed standard departments; b) the Harness zone, and c) special non-standard accommodation to meet the particular needs of individual schemes but designed within the same rules of the game. (FIGURE 4).

The range of standard departments currently available accounts for approximately 70/80% of any District General Hospital and a library of standard profiles for departments of various sizes has been developed for the use of planning teams.



Ground floor plan
1 Mortuary yard. 2 Stand-by generator. 3 Electrical switchgear. 4 Plant for theatres. 5 Gynaecology and ante-natal. 6 Snack bar



First floor plan
1 Segregation unit. 2 Theatre sterile supply unit. 3 Intensive therapy unit. 4 Staff health clinic. 5 Administration. 6 Clinical measurements

Figure 2

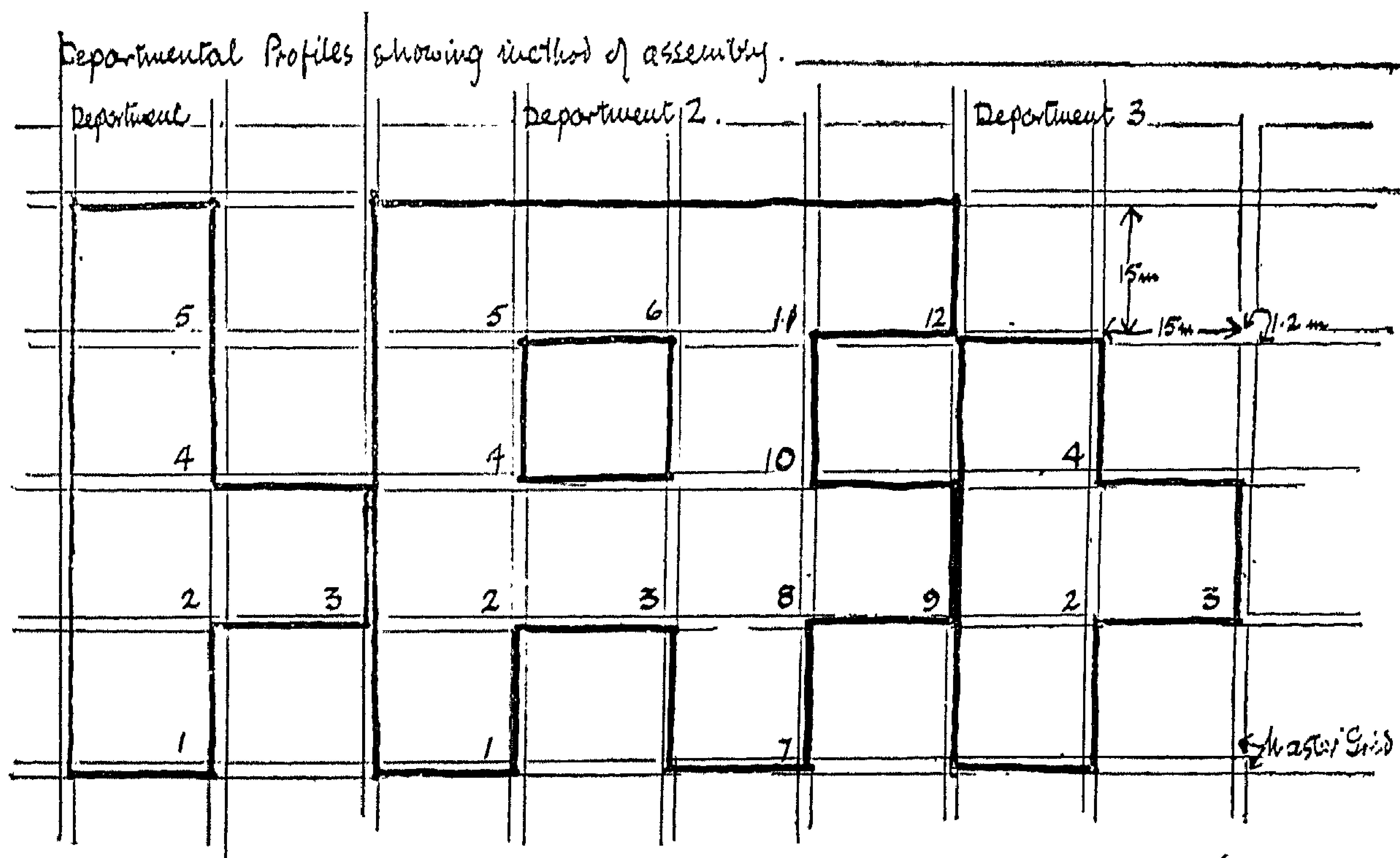


FIGURE 3

Greenwich District Hospital

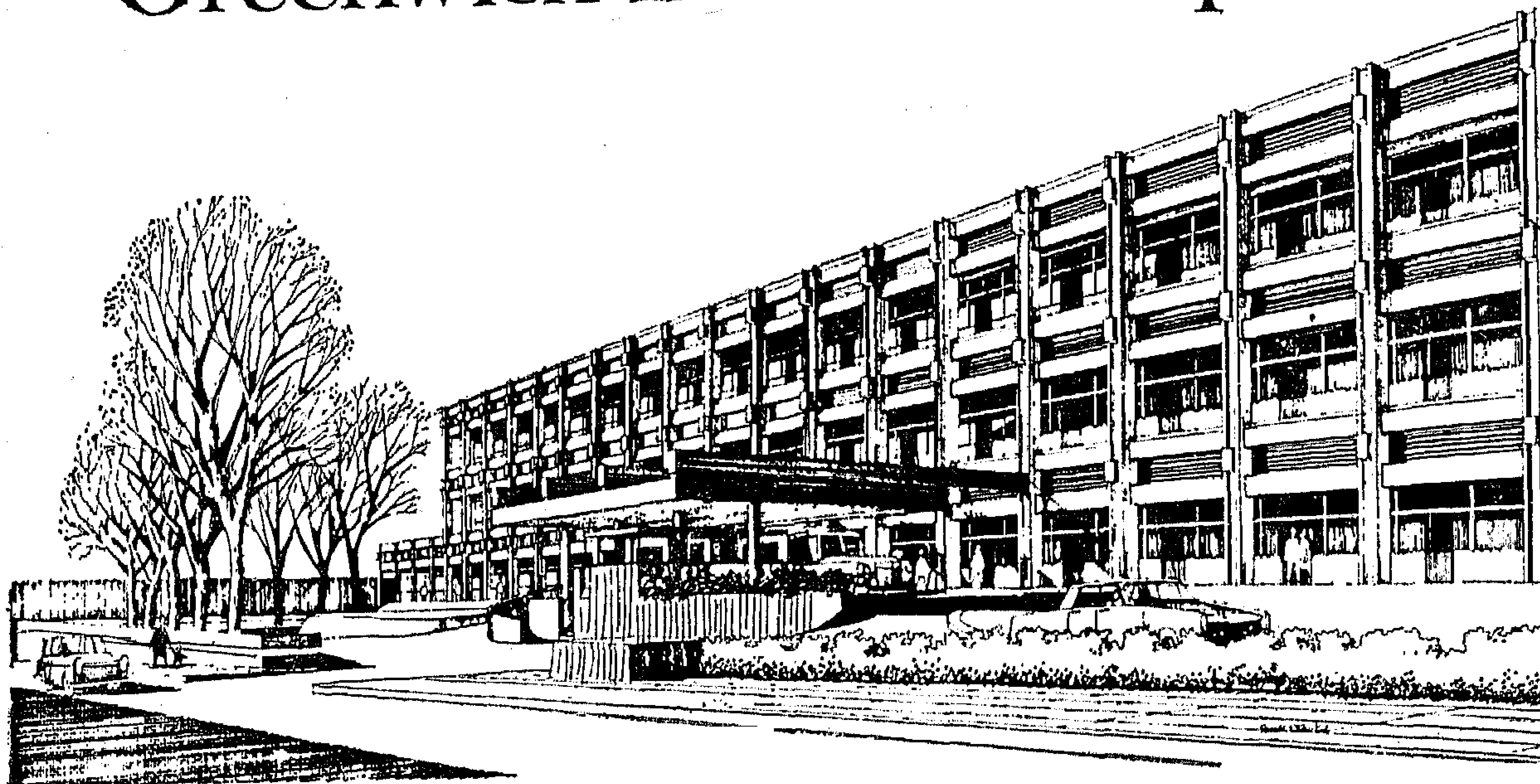


FIGURE 1.

So far as the built form was concerned, it was decided to concentrate on the upper size range of District General Hospitals, i.e. from 700 to 1100 beds. Clearly, any design which is to act simultaneously as a vehicle for standardisation as well as being a forward looking hospital building must not only meet demanding design criteria but must also provide for geometric and dimensional consistency permitting a wide range of hospital shapes and sizes to be planned, using pre-designed standard departmental packages. The design criteria were set down as follows :-

(a) to allow foreseenable growth and ebb and flow of functions between departments throughout the life of the building,

(b) to meet the normal requirements of phasing and decanting,

(c) to be flexible enough to form extensions to existing hospitals,

(d) to provide a unique whole hospital solution out of standard parts in terms of shape and content, which would satisfy the special requirements of each situation, including heavily sloping sites, and.

(e) to meet the environmental requirements of maximum lighting and ventilation.

● Existing hospital shapes and layouts were classified and examined and the investigation concluded that most of the existing built forms were unacceptable. In parallel, the search for an optimal span for the universal envelope was being undertaken which would contain adequately the whole range of hospital activities to be housed within it. The results of these investigations were that a free planning table of 15 metres provided adequate space together with a master structural grid or tartan zone of 1.2 metres. Hence, a dimensional framework was provided within which standard departments could be designed and assembled following rigourously the rules of the game precisely set down and consistently applied. (FIGURE 3). It can be seen that a basic chequerboard pattern emerged within departmental profiles could be established,

HOSPITAL SYSTEMS AND STANDARDS IN THE UNITED KINCDOM

A general review of a current development in hospital planning and design by:-

HOWARD GOODMAN. Dip. Arch. (Hons)., A.R.I.B.A,*

and

RAYMOND MOSS, M.B.E., Dip. Arch,, A.R.I.B.A.**

● Many people still understand the term 'hospital design' as applying specifically to buildings, furniture and equipment. But, over the last five years in Great Britain this term has taken on a new and more comprehensive meaning. In this country 'hospital design' is now seen as being a continuous process or system encompassing a number of sub-systems; briefing - designing - producing - constructing - using and evaluating, and the expression used to cover this new unified approach is 'systems and standards'.

The 'systems and standards' programme was conceived in the Department of Health & Social Security and it has been developed by the Department, the Regional Hospital Boards, and a large number of consutiants on a multi-professional team basis. Doctors, administrators, nurses, engineers, architects, supplies officers, quantity surveyors, interior designers, landscape architects, systems analysists and computer scientists have all made significant contributions.

The aims of the 'systems and standards' programme are as follows :-

(a) to make the greatest use of the limited resources of skilled hospital planners and designers,

(b) to reduce substantially the briefing and design time for a given project, and.

(c) to provide highly detailed and coordinated packages of building and engineering information complete at the time of tendering.

● Hospital planners in the Department of Health and Social Security building on their earlier research and development experience, particular at Greenwich (FIGURE 1) and the identical twin hospitals at Bury St. Edmunds and Frimley, which have become known as 'Best Buy' hospitals (FIGURE 2), conceived the idea of a universal envelope enclosing a space of standard dimensions as a basis for standard designs, backed up by a rationalised briefing and production methodology. And, as an additional time saver it was proposed that mechanical processing, both in the fields of design and information should be incorporated wherever these were shown to be effective and economic. In all this work a reduction of the time taken from inception to completion of a major hospital project was regarded as being of vital importance, especially bearing in mind the rate of obsolescence experienced in medical building.

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Fig 9 shows the values of μ for different circular bridges with various values of K ratios.

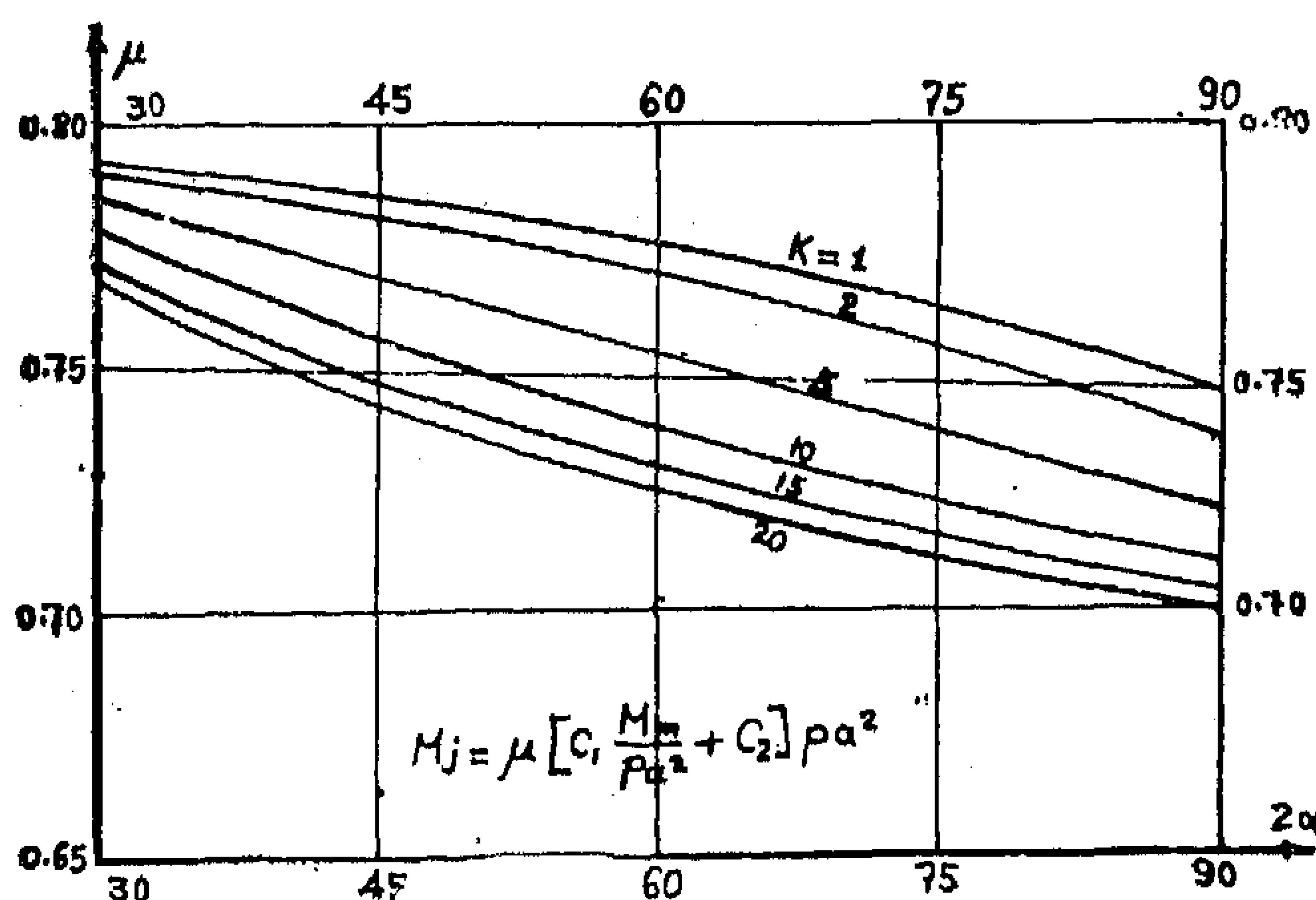


Fig. 9.

5 — Circular bridge of n spans subject to uniformly distributed load;

Fig. 10 represents a circular bridge of n equal spans subjected to a uniformly distributed load w. The bridge has constant bending and torsional rigidities. An isolated span ABCD can be considered fixed at its ends and hence the rotations there are equak to zero. From symmetry, the two restraining moments M_1 and M_2 are equal.

Applying the method of virtual work and using the results of the simple span bridge, the connecting moment can be given by,

$$M_1 = (\lambda_1 \frac{M_m}{pa^2} + \lambda_2)\ pa^2 \text{ where } p= wa,$$

$$\lambda_1 = [(\frac{2\ \alpha}{\sin\ 2\ \alpha} - 1) - \frac{1+k}{2\ \alpha\ \tan\ \alpha\ /\ 2}\ /C'.$$

The resulting reactions, bending and torsional moments may be obtained from the equations of statics.

6 — Summary

Using simplified assumptions, circular box-girder bridges are solved by the conventional method of virtual work. Influence surfaces of the redundant reactions and internal forces are constructed for direct use of engineers.

The proposed solution covers the cases of simple and continuous bridges. Owing to its special importance, the case of uniformly distributed load is treated in detail.

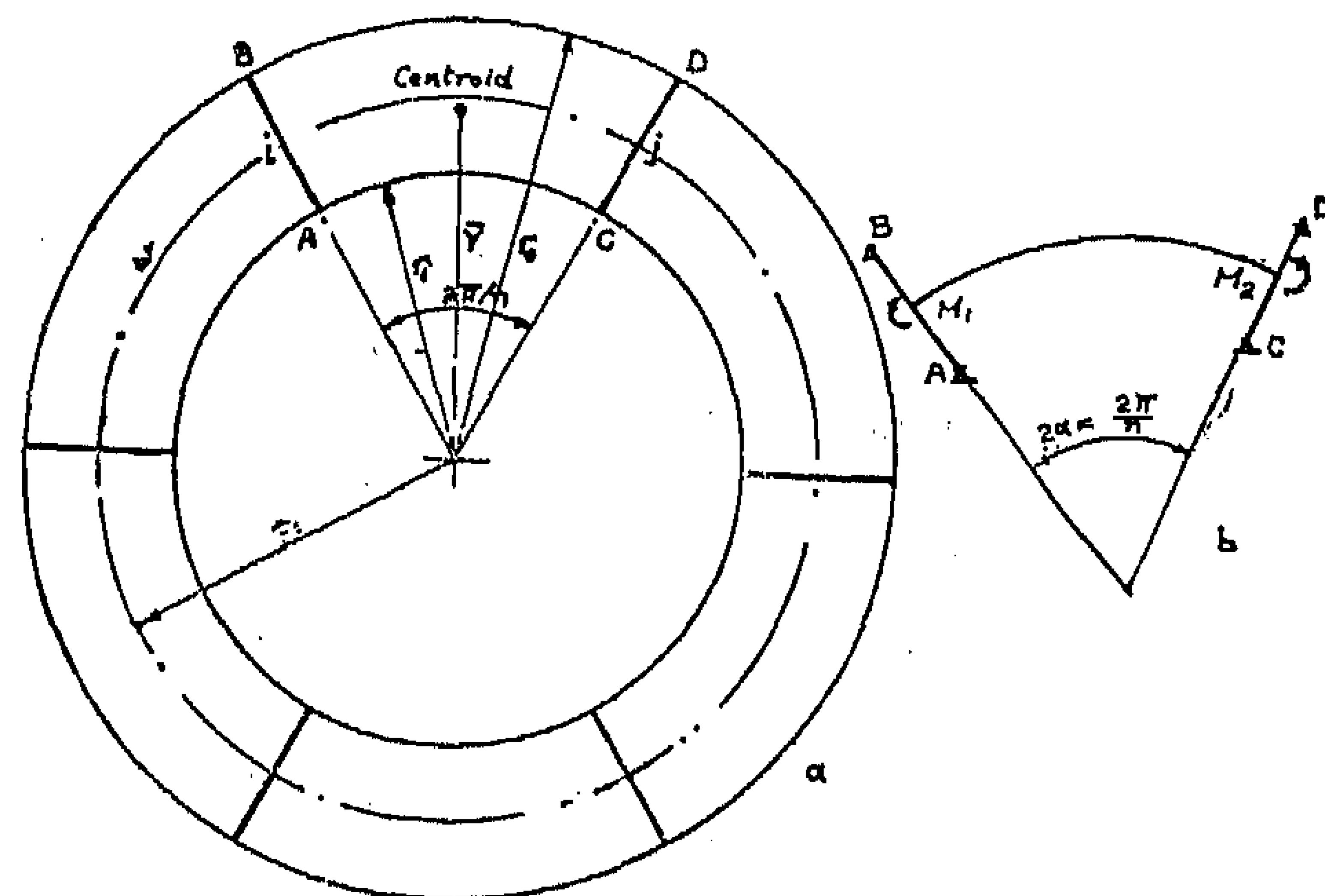


Fig. 10.

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4 — Three-span continuous bridges;

Fig. 7 shows a three-span circular bridge, The bridge is 5-times statically indeterminate. Using the results obtained before for the simple span bridge, the number of unknowns can be reduced to two only. It is assumed that the three spans are equal and have constant bending and torsional rigidities.

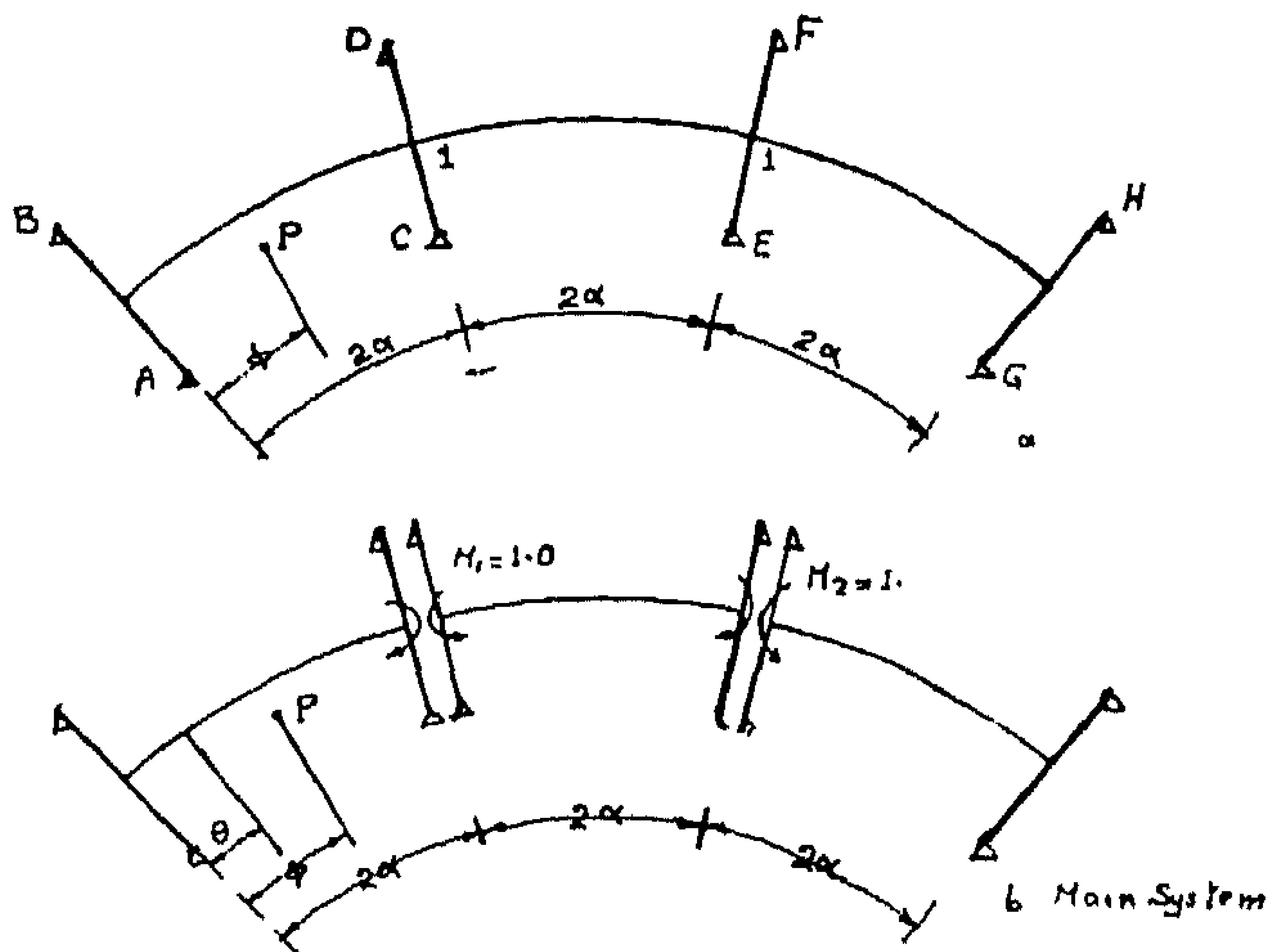


Fig. 7.

Applying the method of virtual work and using the results of the simple span bridge, the redundant connecting moments can be obtained. The analysis of the bridge is completed as mentioned before. Fig. 8 shows the I.S. of the connecting moment M_1 for a three-span bridge with

$\frac{r_i}{r_o} = 0.8$ and K = 2.

Case of uniformly distributed load (w);

$M_1 = \mu M_j$ where

$$\mu = \frac{1}{1 + \beta_{12} / \beta_{11}}, \quad \beta_{11} = \frac{a}{EI} C,$$

$$\beta_{12} = \frac{a}{EI} \left[\frac{1}{2 \sin 2\alpha} \right\} (-K) - 2\alpha \, (1+K) \cot 2\alpha \left\} + \frac{k}{2\alpha} \right]$$

M_j = connecting moment for a 2-span bridge. p= wb.

This equation can be put in the form;

$$M_1 = \mu \left(C_1 \frac{M_m}{pa^2} + C_2 \right) pa^2$$

μ, C_1, C_2, M_m are given before.

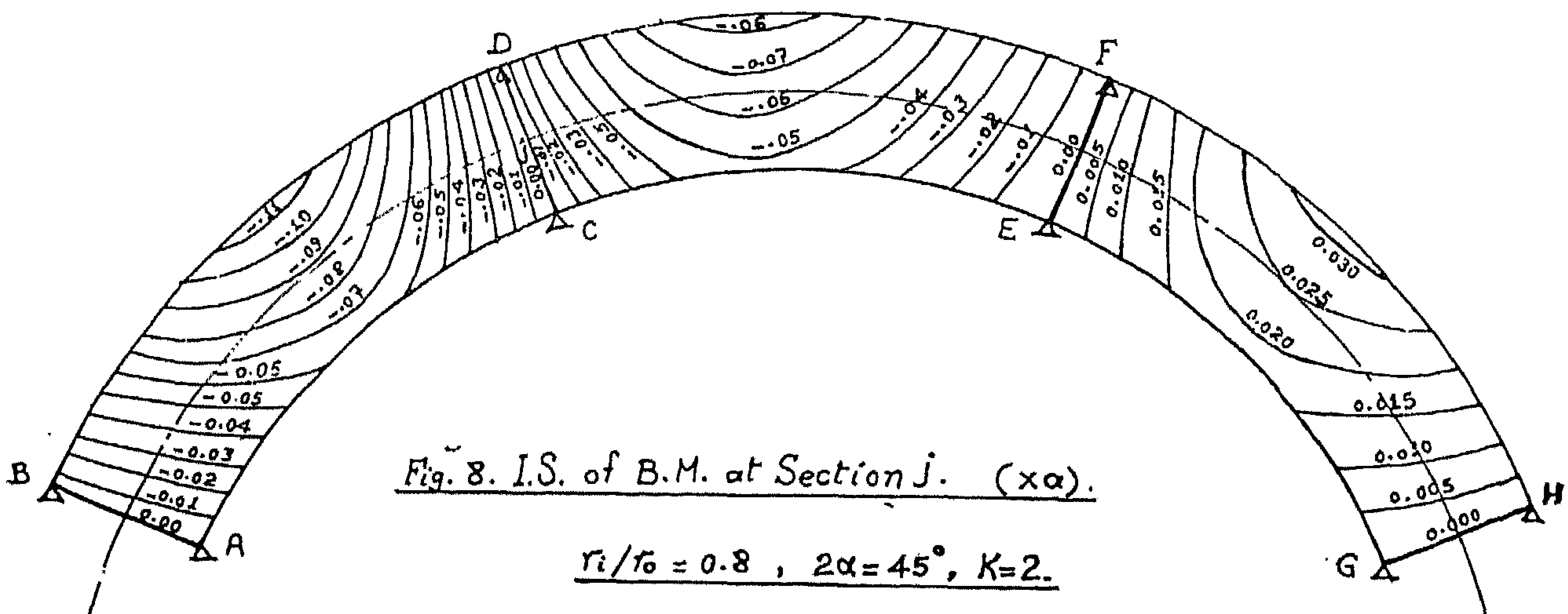
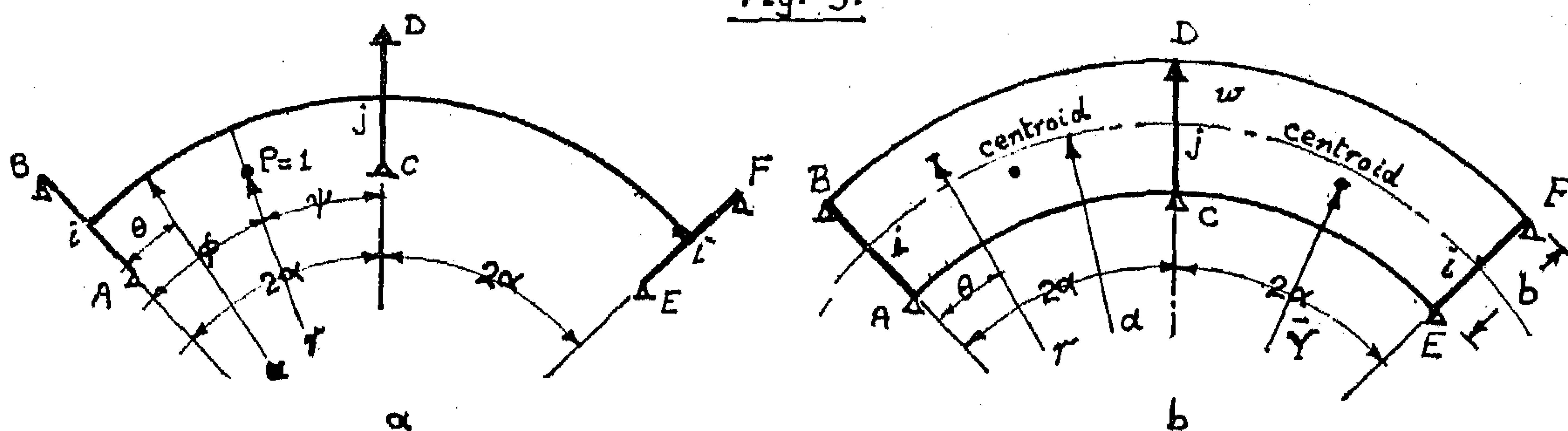


Fig. 8. I.S. of B.M. at Section j. (xa).

$r_i/r_o = 0.8$, $2\alpha = 45°$, $K=2$.

Fig. 5.



obtained before for the simple-span bridge.

The analysis of the bridge is done by virtual work and the results of some special cases of loading Fig. 5 are given.

a) Unit load at an arbitrary point (r, ϕ);

$$M_j = a \left[\left(\frac{a \sin \psi}{\sin^2 2\alpha} - \frac{\cos \phi}{2 \sin 2\alpha} \right) (1 + K) \frac{r}{a} - K \left(\frac{\sin \phi}{\sin 2\alpha} - \frac{\phi}{2\alpha} \right) \right] / C.$$

where,

$$C = \frac{2\alpha}{\sin^2 2\alpha} (1 + K) - (1 - K) \cot 2\alpha - \frac{K}{\alpha}.$$

b) Bridge subject to uniformly distributed load (w);

$$M_j = 2\alpha \left[\left(\frac{2}{\sin 2\alpha} - 1 \right) \frac{1 + K}{2 \cos} \frac{Y}{a} - K \left(\frac{\tan \alpha}{\alpha} - 1 \right) \right] pa^2/C$$

This equation can be put in the form

$$M_j = \left[C_1 \frac{M_m}{pa^2} + C_2 \right] . pa^2 \quad \text{where,}$$

$$C_1 = \left(\frac{2\alpha}{\sin 2\alpha} - 1 \right) (1 + K) \cot \frac{\alpha}{2} / C$$

$$C_2 = -2K (\tan \alpha - \alpha) / C$$

M_m = the bending moment at the middle of the simple span bridge given middle of the simple span bridge given before. and p = w.b.

Using the results of case a), the I.S. of M j can be evaluated. The values of the reactions and internal forces can be computed by making use of this I.S. and the results of the simple span bridge. Fig. 6 shows the I.S. of M j for two different bridges.

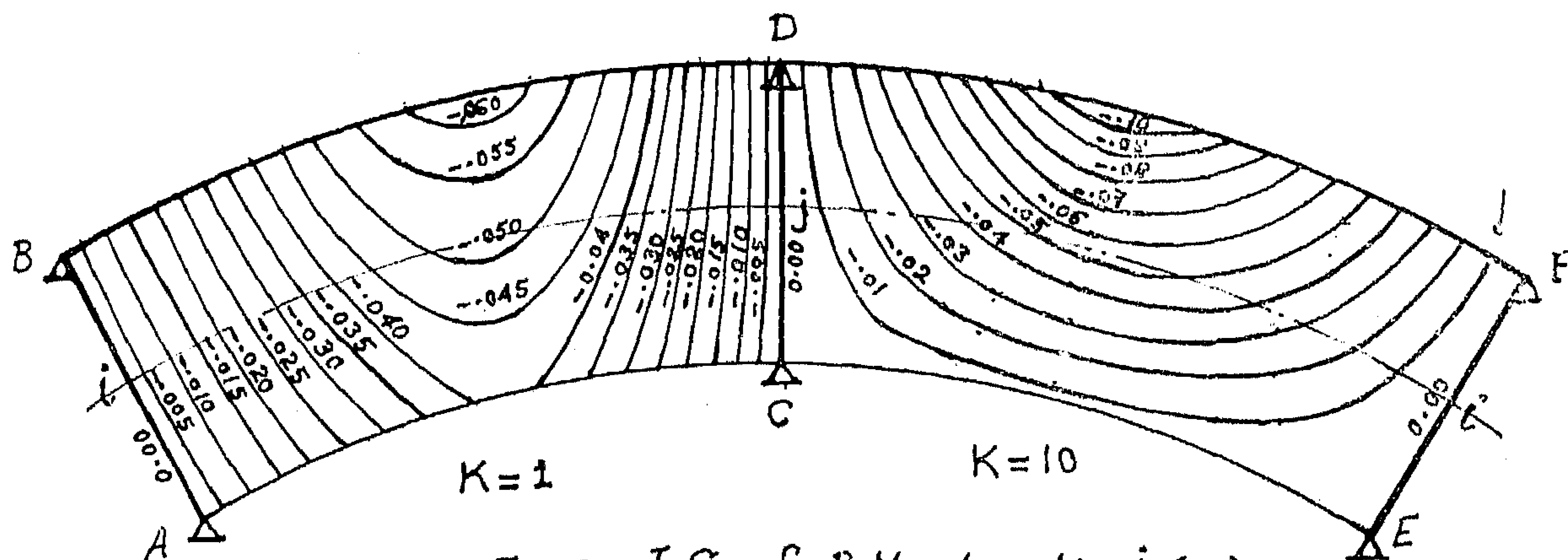


Fig. 6. I.S. of B.M. at section j (×a)

$r_i/r_o = 0.8$, $2\alpha = 30°$

c) Case of uniformly distributed load (w);

Due to symmetry, the bridge is statically determinate. The centroid of the bridge can be given by,

$$\bar{Y} = \frac{4}{3}\left(1 - \frac{r_i\, r_o}{4\, a^2}\right)\frac{a \sin\alpha}{\alpha} .$$

The reactions are;

$$A = C = \alpha\frac{r_o}{b}\left(1 - \frac{\bar{Y}}{r_o \cos\alpha}\right) pa ,$$

$$B = D = \frac{r_i}{b}\left(\frac{\bar{Y}}{r_i \cos\alpha} - 1\right) pa, \text{ where } p = wb$$

For any point (r, θ),

$$M_\theta = \frac{\bar{Y}}{a}\,\frac{\alpha}{\sin\alpha}\,(\tan\alpha \cdot \sin\theta + \cos\theta - 1)\,pa^2$$

$$M_{max.}\ (\theta = \alpha) = \alpha\,\frac{\bar{Y}}{a}\,\frac{\tan\alpha/2}{\cos\alpha}\,pa^2.$$

$$T_\theta = -\alpha\left(1 - \frac{\theta}{\alpha} + \frac{\bar{Y}}{a}\,\frac{2\sin(\theta-\alpha)}{\sin 2\alpha}\right) pa^2 .$$

From the above expressions, it can be noticed that the volumes of the reactions of the simple span circular bridge are independant of the values of $K = \frac{EI}{GJ}$ of the bridge. The values of the reactions A & C may be positive or negative.

Using the results of case of loading a), the I.S. of reactions and internal forces of bridge can be determined. This was done for different bridges chosen in such a way to cover a wide range of practical cases. Fig. 3 shows the I.S. of the reaction A, the bending moment and the torsional moment in a bridge with $2\alpha = 45°$ $\frac{a}{b} = 0.3$.

3 — Double-span box-girder circular bridges;

Fig. 4 shows a double-span circular bridge with constant EI and GJ. The bridge is 3-times statically inditerminate. However; the number of unknowns can be reduced to one by using the results

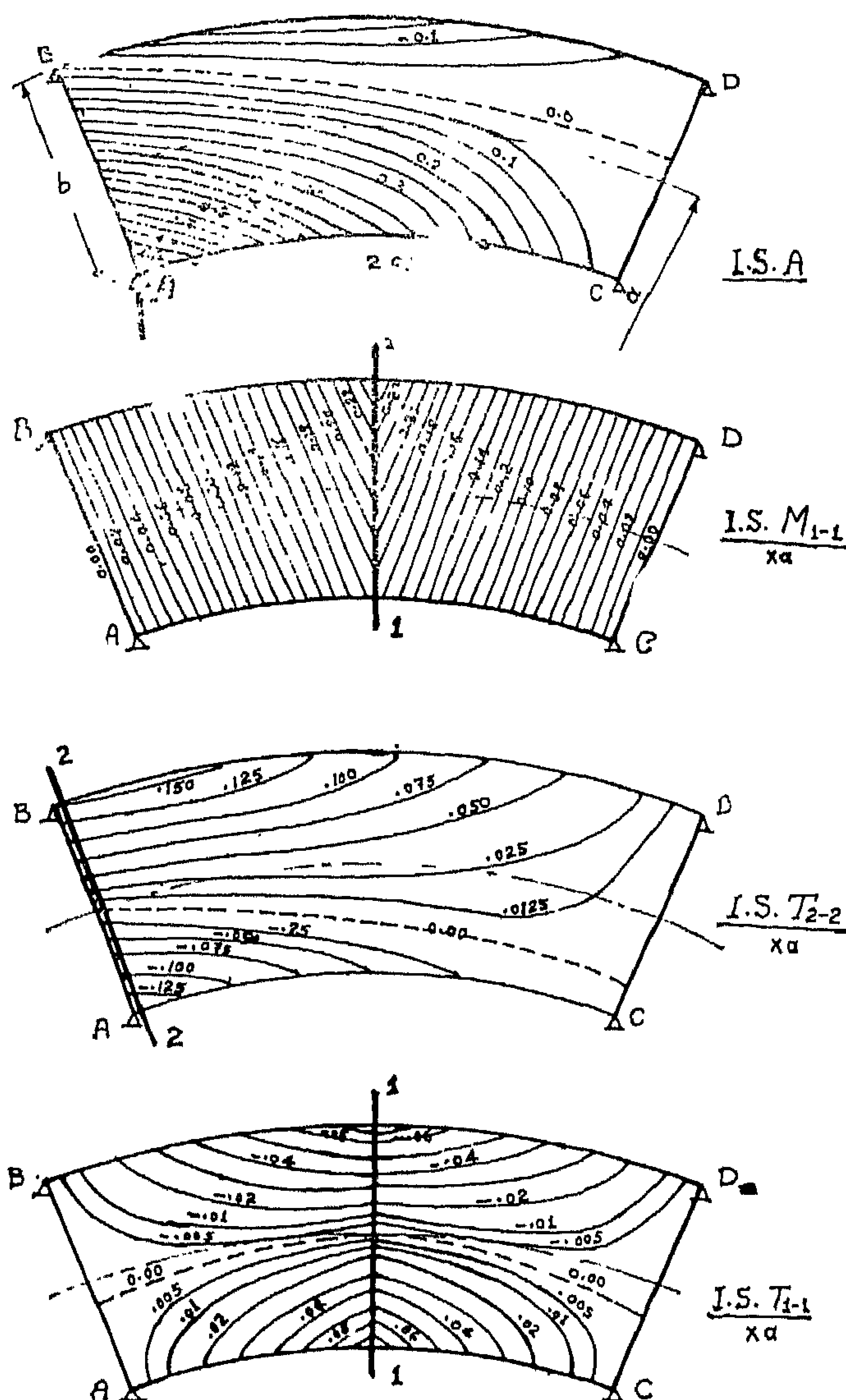
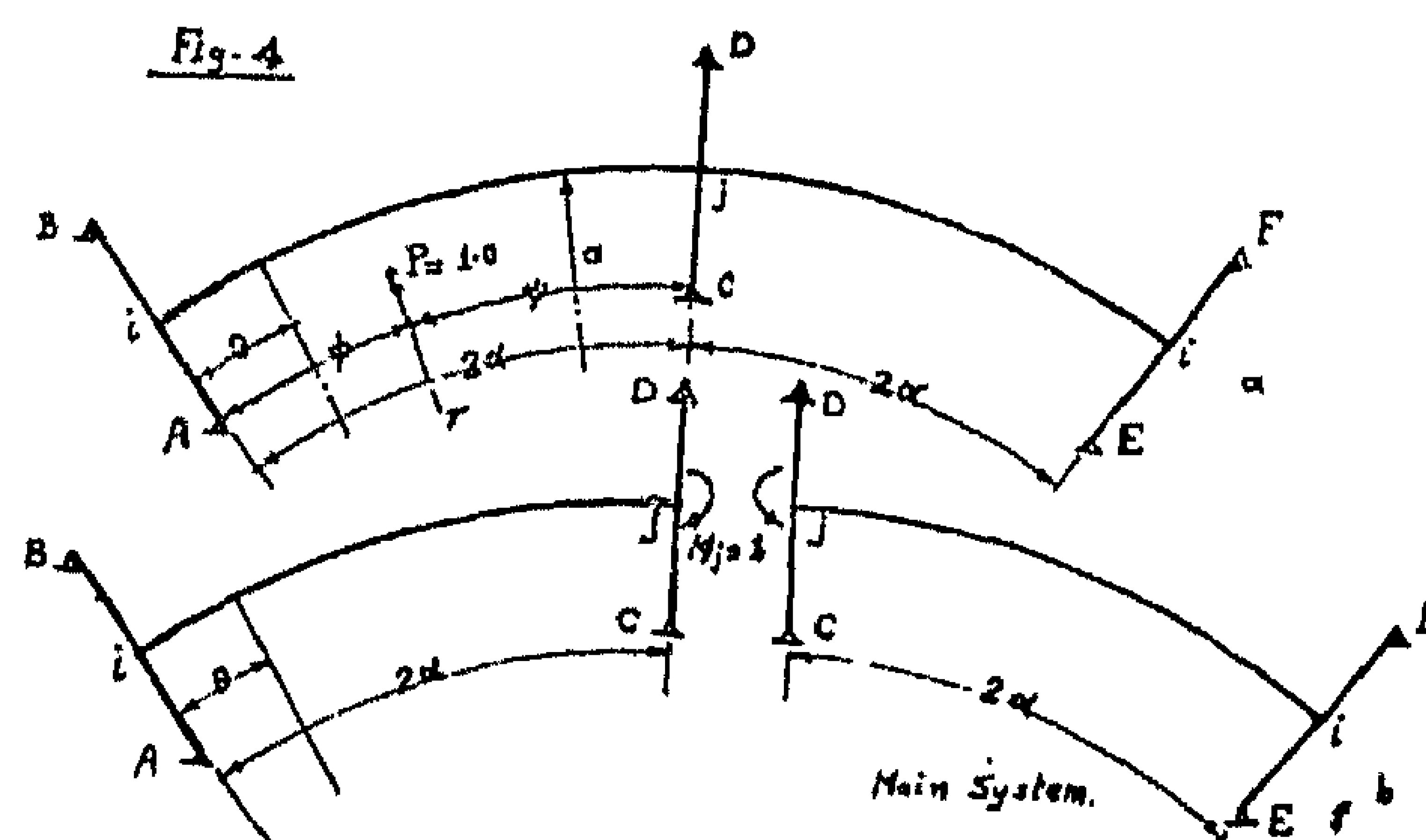


Fig. 3 - I.S.s for a simple box-girder circular bridge

$2\alpha = 45°$ & $\frac{b}{a} = 0.3$



pendicular to the plane of the bridge at an arbitrary position (r, ϕ). The main system can be formed by removing a vertical reaction V. Using the method of virtual work, the redundant reaction can be obtained.

$$V = -\frac{\delta_{01}}{\delta_{11}} \qquad \text{With} \qquad (1)$$

$$\delta_{10} = \int \frac{M_0 M_1}{EI} ds + \frac{T_0 T_1}{GJ} ds \quad \text{and}$$

$$\delta_{11} - \int \frac{M^2_1}{EI} ds + \int \frac{T^2_1}{GJ} ds \quad \text{where,}$$

EI, GJ are the bending and torsional rigidities of the beam,

M, T are the bending and torsional moments about the centre line of the curved beam.

Indices O,l refer to the main and virtual loads respectively.

In the following the redundant reaction A, the bending moment and the torsional moment are given for some special cases of loading, Fig. 2.

a) Unit load at an arbitrary point (r , ϕ);

$$A = \frac{r_0}{A} \left(\frac{\psi}{2\alpha} - \frac{r \sin \psi}{r_0 \sin 2\alpha} \right) .$$

$$M_\Theta = \frac{r \sin \psi}{a \sin 2\alpha} \sin \Theta \quad , \quad \Theta \leq \phi$$

$$T_\Theta - a \left(\frac{r \sin \psi}{a \sin 2\alpha} \cos \Theta - \frac{\psi}{2\alpha} \right) .$$

$$M_\Theta - a \left[\frac{r \sin \psi}{a \sin 2\alpha} \sin\Theta - \frac{r}{a} \sin (\Theta - \phi) \right]$$

$$T_\Theta - a \left[\frac{r \sin \psi}{a \sin 2\alpha} \cos \Theta + \frac{\phi}{2\alpha} - \frac{r}{a} \cos (\Theta - \phi) \right] \qquad \phi \angle \Theta \leq 2\alpha$$

b) Straining moment M_0 at one end;;

$$A \quad -\frac{M_0}{b} \left(\frac{1}{\sin 2\alpha} - \frac{r_0}{a} \frac{1}{2\alpha} \right)$$

$$M_\theta = -\frac{M_0}{\sin 2\alpha} \sin \theta , \quad T_\theta = - M_0 \left(\frac{\cos \theta}{\sin 2\alpha} - \frac{1}{2\alpha} \right)$$

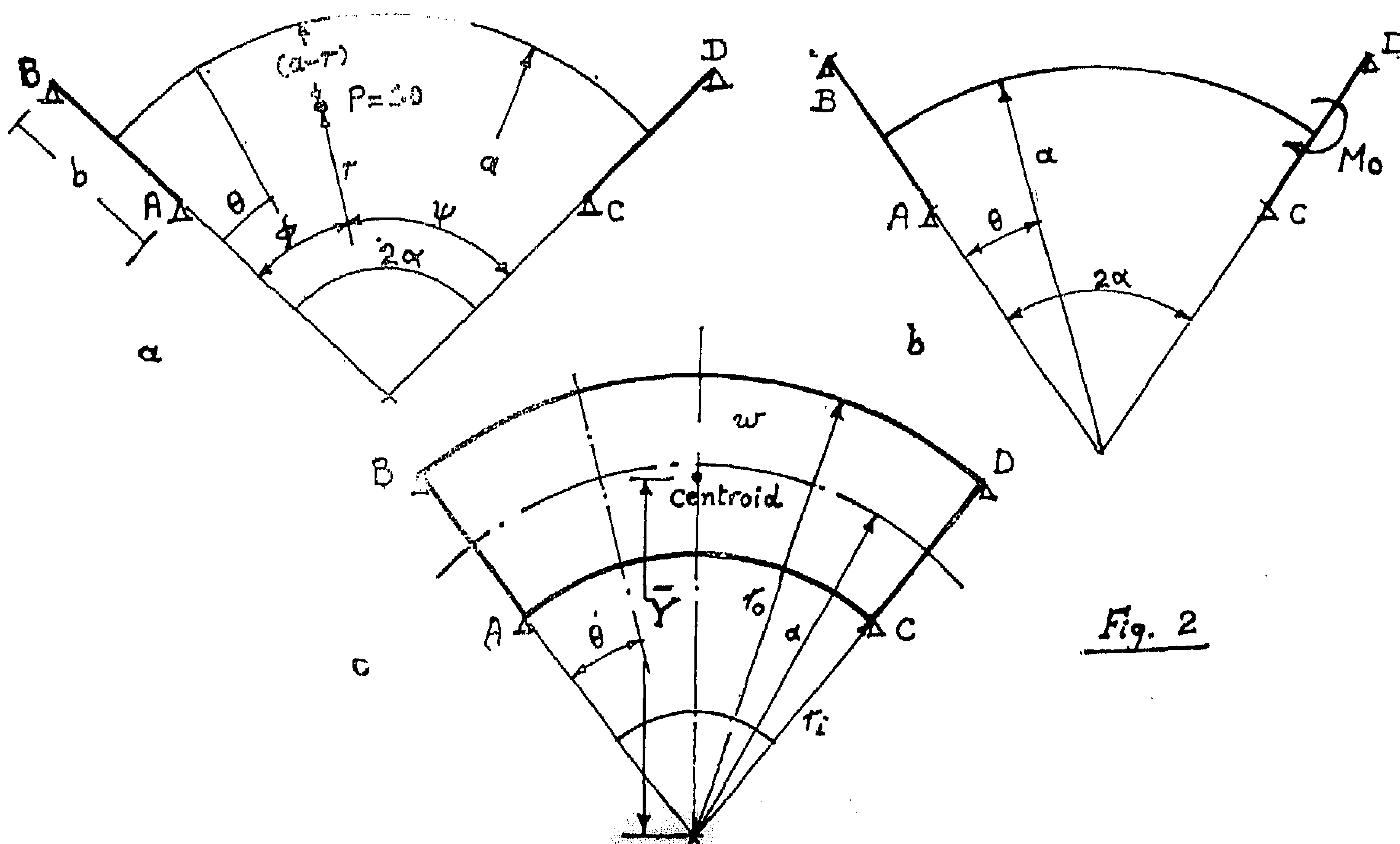


Fig. 2

CIRCULAR BRIDGES WITH BOX-SECTIONS

By

Prof. M.H. KHORSHED (D.Sc. techn.),
H.A. ABDEL WAHAB (Dr. Ing.
and **F.M. EL-AMIN** (M.Sc.)

1 — INTRODUCTION:

Curved bridges are frequently met in practice. Site conditions and road alignment often necessiate the construction of such bridges. The solution of curved bridges has been discussed by many authors. Generally, bridges with polygonal shape in plan have been investigated. Few trials have been made in which the bridge was treated as a curved beam.

In 1914, Kapsh (1) gave an approximate analysis for the curvature effect in bridges. Statically determinate space curved bridges with one wind bracing were investigated by Kühl E. (2), 1937, assuming that the points of the polygonal main girders are connected by cross gir ders Stüssi F. (3), 1937, considered, the curved space bridge with polygonal (in plan) main girders as one carrying sys tem composed of a series of vertical planes and a horizontal bracing. He obtained a relation between the bending and torsional moments and shearing farces in from of two systems of implicit equations for the outside and inside main girders. M.H. Khorshed (4), 1957, studied the solution of through truss bridges, having one system of bracing, with polygonal main girder and subjected to lateral forces.

Bechert (5), 1963, investigated the solution of simple span circular bridges having box having box cross-sections using the known formulae of the elastic lines of curved beams. However, his analysis seams to be impractical specially when applied to continuous curved bridges.

The main object of this work is to develop a general solution for, simple and continuous, circular bridges with box cross-sections. To simplify the application of this solution, influence surfaces (I.S.) of reactions and internal forces are constructed for different bridges covering a wide range of practical cases.

2 — Simple box-girder circular bridge;

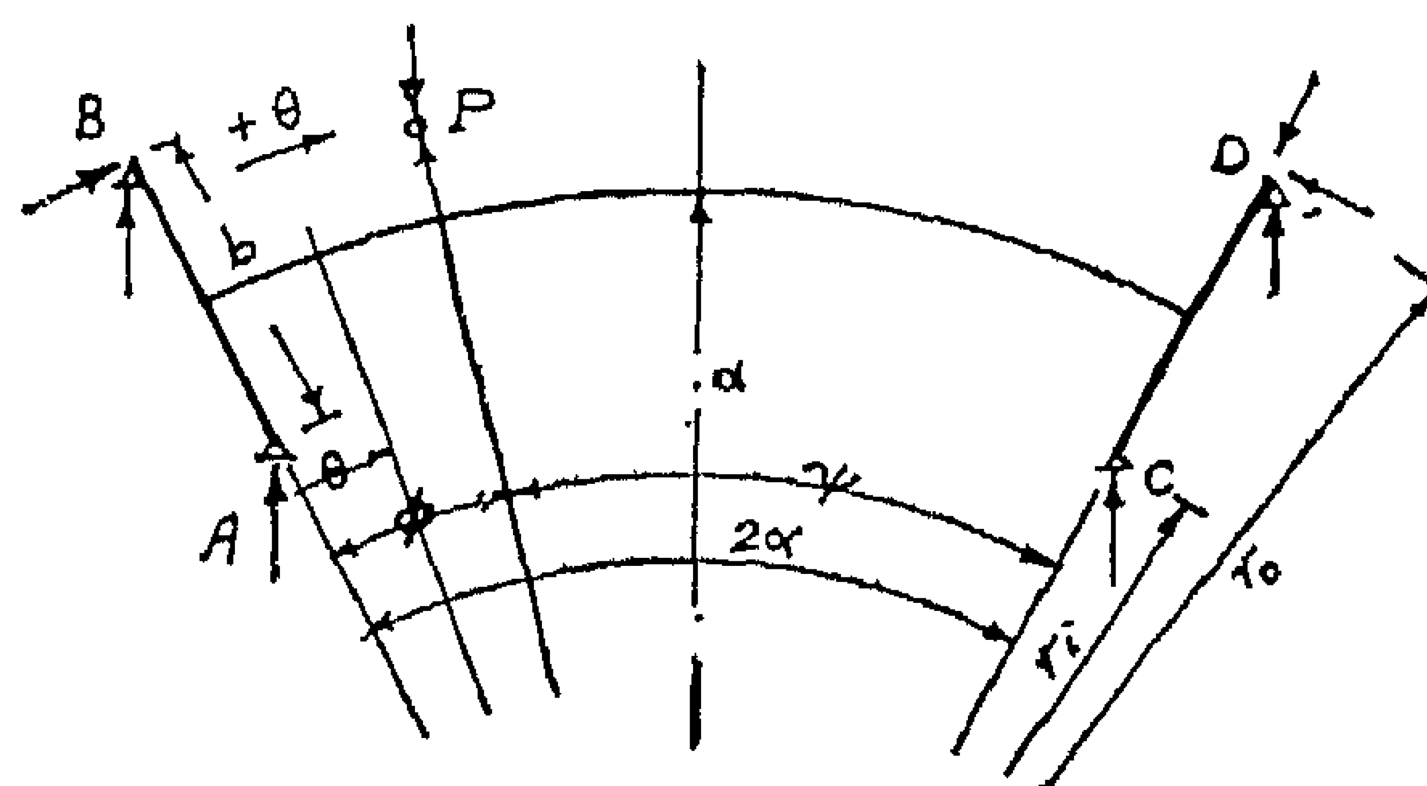


Fig. 1.

The bridge shown in Fig. 1, is once statically indeterminate. Owing to its high torsional rigidity, the torsional deformations are considered in the analysis of the bridge.

The bridge is treated as a circular girder. The bending and torsional rigidities are assume concentrated along its axis. Further, the circular girder is considered rigidly connected to the middle of two perpendicular infinitly rigid cross-girders at its ends. The two end cross-girders rest on the four supports of the bridge.

A concentrated load P is applied

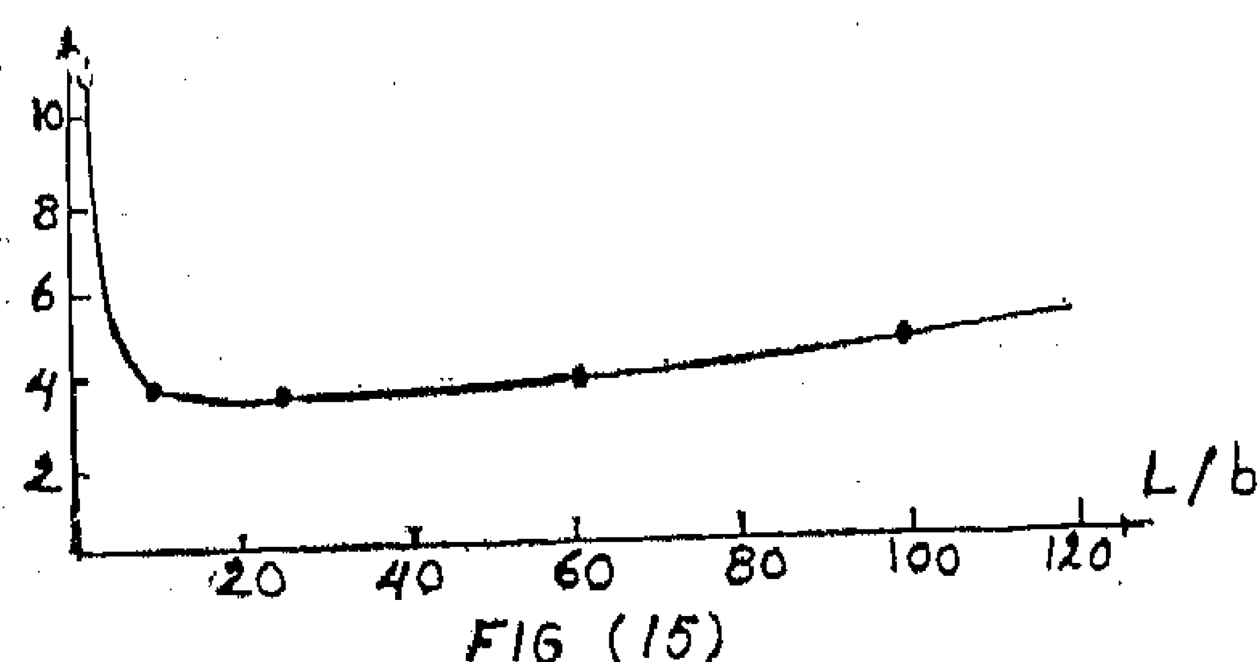


FIG (15)

mentum principle treating the construction as a combination of a sudden contraction and sudden enlargement. The energy approach seems to be more useful for practical purposes in Irrigation Design Problems.

A comprehensive and wide ranged series of experiments were conducted for the present work where the vent to channel widths, the pier length to vent opening, the discharge, the velocity and the water depth were widely varied and tested. Altogether 220 different experiments were conducted and complete water surface profiles were surveyed in 81 different runs of these experiments. The experiments included both free and submerged downstream condition. Analysis of these experimental results revealed that :

1 — A maximum submergence ratio (downstream to upstream water depths) of 0.80 is obtained for a ratio of pier length to vent opening of about 4.0. This submergence limit was found to be independent of the value of discharge passing and of the water depth.

Increasing the value of the ratio L/b over 4.0 results in a decrease in the submergence limit though at much smaller rates than the case when decreasing the L/b ratio. Therefore the value L/b of about 4.0 is recommended in the design of regulators and smaller values should be avoided.

2 — Treating the flow withen the vent as that for a venturiflume proved to be unuseful approach for practical purposes in Irrigation Design Problems. On the other hand, adopting the principle of the critical depth meter proved to be more useful for representing the flow through vents. Analysis of the results showed that the equation $Q = \bar{c}\, b\, Y_I^{3/2}$, represents fairly well the experimental findings. The value of the coefficient $\bar{c}$ was found almost to be 1.63 for values of L/o of 4 and greater. This value is smaller than the theoriticol value of 1.703 due to friction asd velocity losses.

3 — The head losses through the vents can be expressed as a multiple of the velocity head in uniform flow in the channel such that $H = \alpha V2/2g$ with with the value of α assuming a value around 4.0 for values of L/b greater than 4.0.

It therefore can be adopted in the problems concerning the design of regulator vents and similar problems

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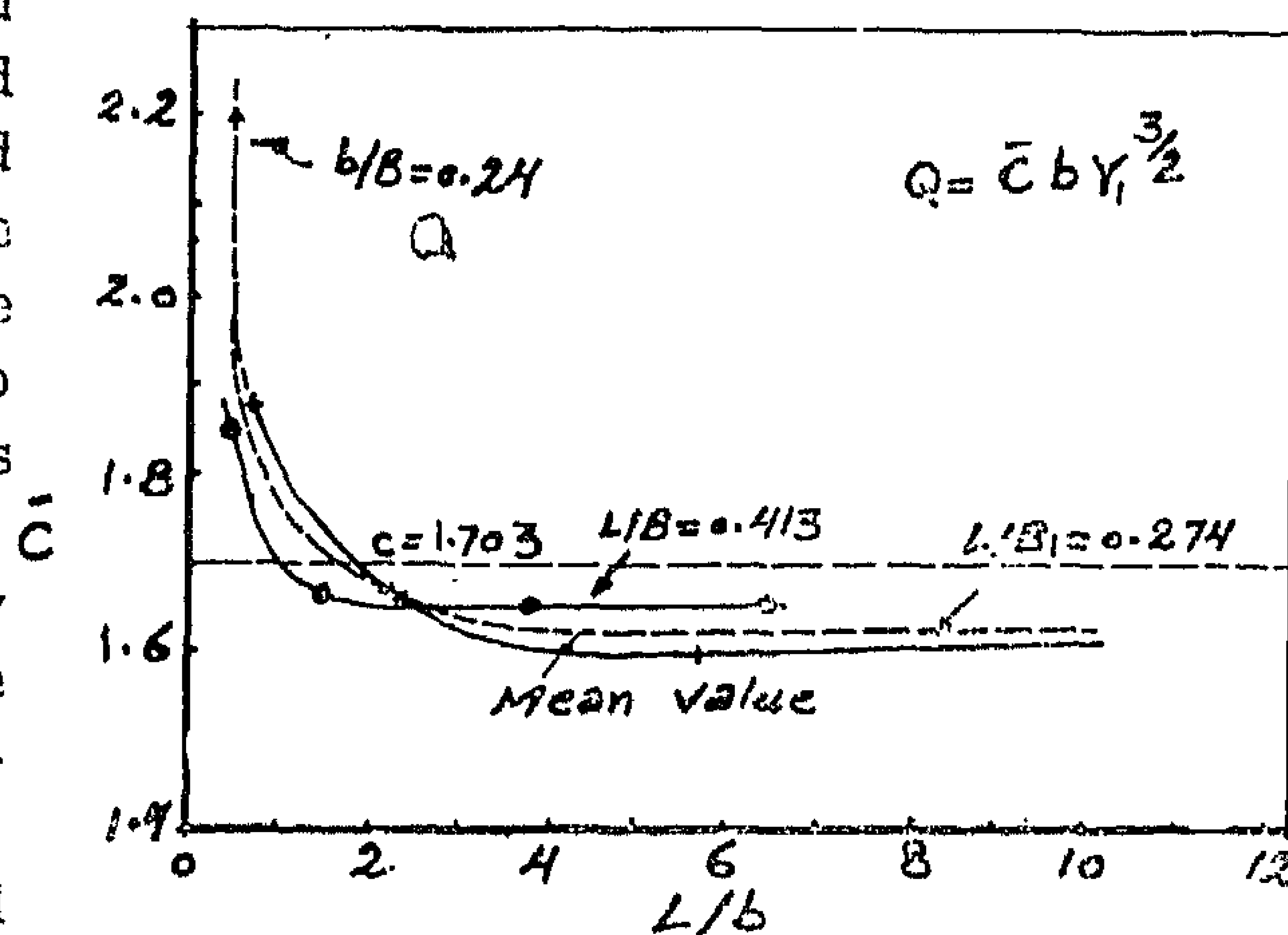
the treatment of flow through vent, the coefficient c was calculated for the different runs and was plotted against the Froude's number F_1 upstream as shown in figure (13). As seen from the figure different and distinct curves are obtained for each L/b ratio and each partiular curve also shows a marked variation of c with flow conditions as represented by the Froude's number F_1 . It therefore appears that treating the flow withen the vents as that for a venturiflume does not represent an easy and ready approach for particular purposes in irrigation design problems.

Adopting the principle of the critical depth meter on the other hand (equation 9), the results are plotted in figure (14) to a basis of L/b . The figure clearly reveals that the equation,

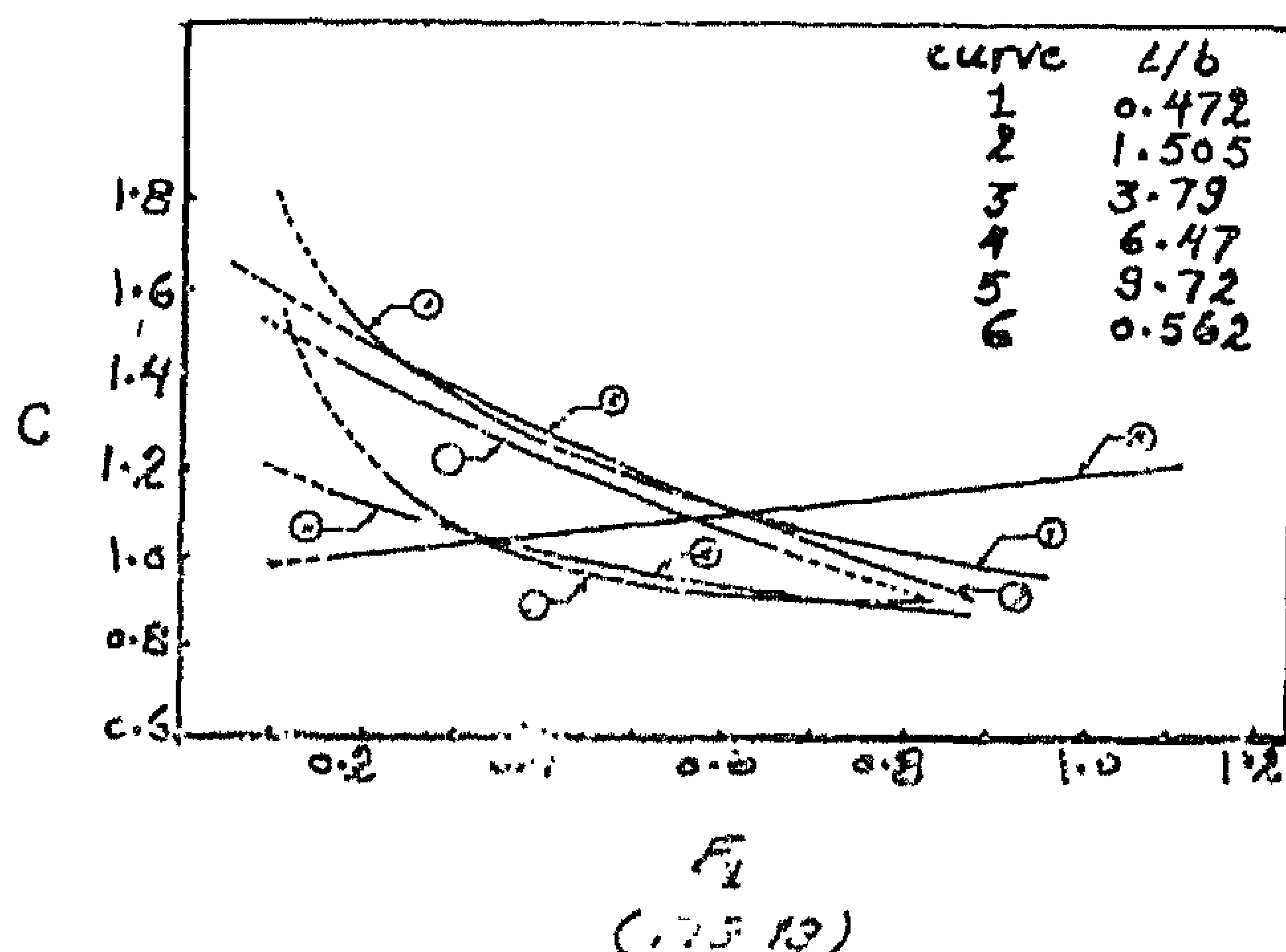
$$Q = \bar{c}\, b\, Y^{3/2}$$

better represents the results obtained, and that for values of L/b around 4.0 and greater the coefficient c is constant and has an average value of 1.63. The value of 1.63 is smaller than the theoritical value of 1.703 due to friction losses and due to the fact that the velocity of approach was neglected in the equation.

Regarding total head losses of the flow through vents, calculations were made from the experimental results using equation (2). The quantity $Y_1 - Y + 1/2g\ (V^2_1 - V^2)$, represents the total head loss H appearing in equation (1). It includes eddy losses in the downstream and upstream separation zones, together with friction losses through the vent itself. The total head loss H was expressed as a fraction of the velocity head in the normal flow $V^2/2g$ or in other words, H was put $= \alpha\, V^2/2g$. Figure (15) shows the calculated values of α plotted against the ratio of pier length to vent width. It is seen from this figure that for values of L/B = 4 and greater the value of α varies from 3.5 to 4.5 or on the average = 4 . It therefore appears satisfactory for practical purposes in Irrigation Design Problems, to calculate the head losses through regulator and bridge vents as a factor α of the uniform flow velocity head. α For practical purposes α may be chosen to have the mean value of 4.0 for ratios of pier length to vent opening greater than 4 which is always encountered in practice.



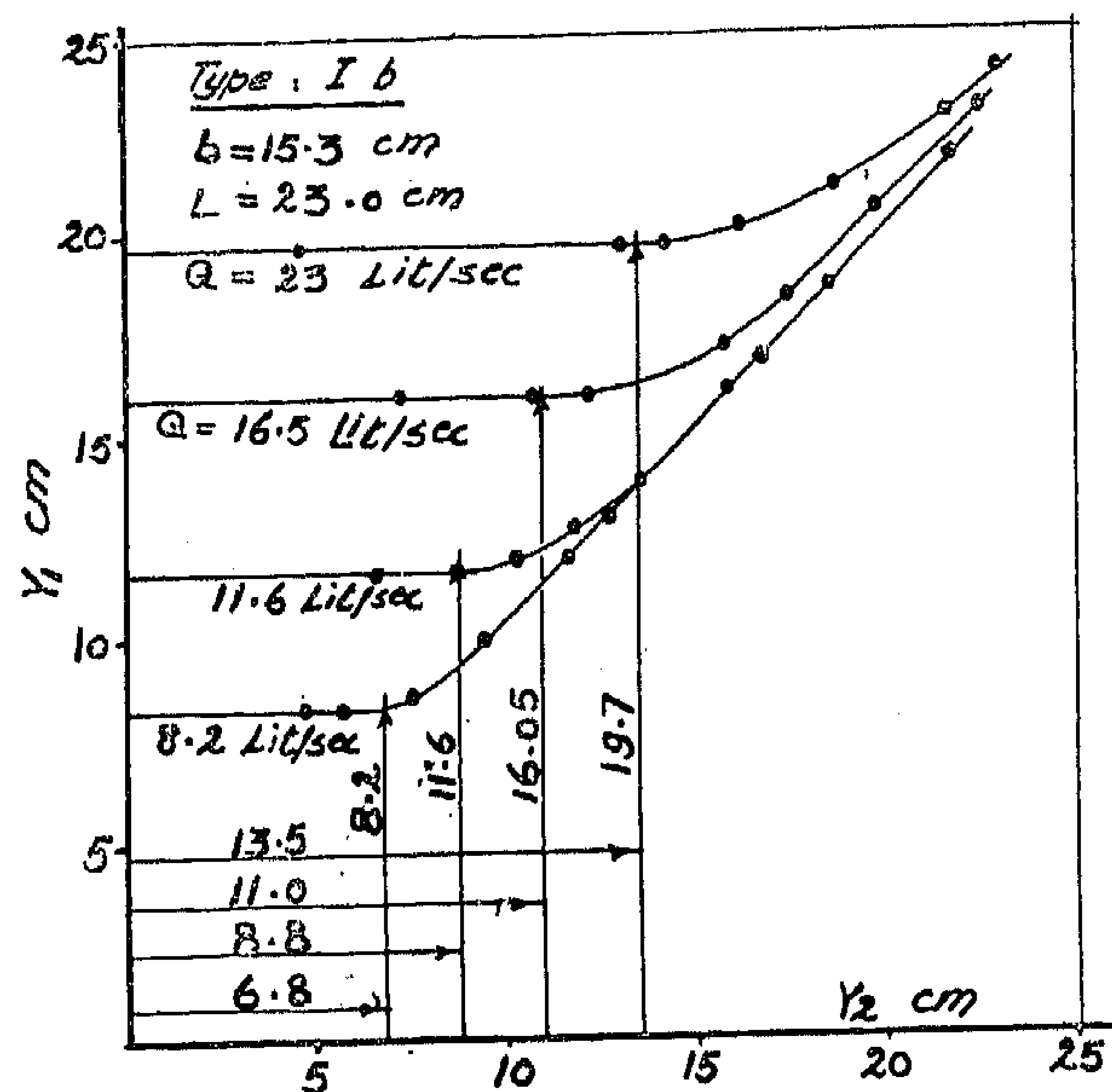
(FIG. 14)



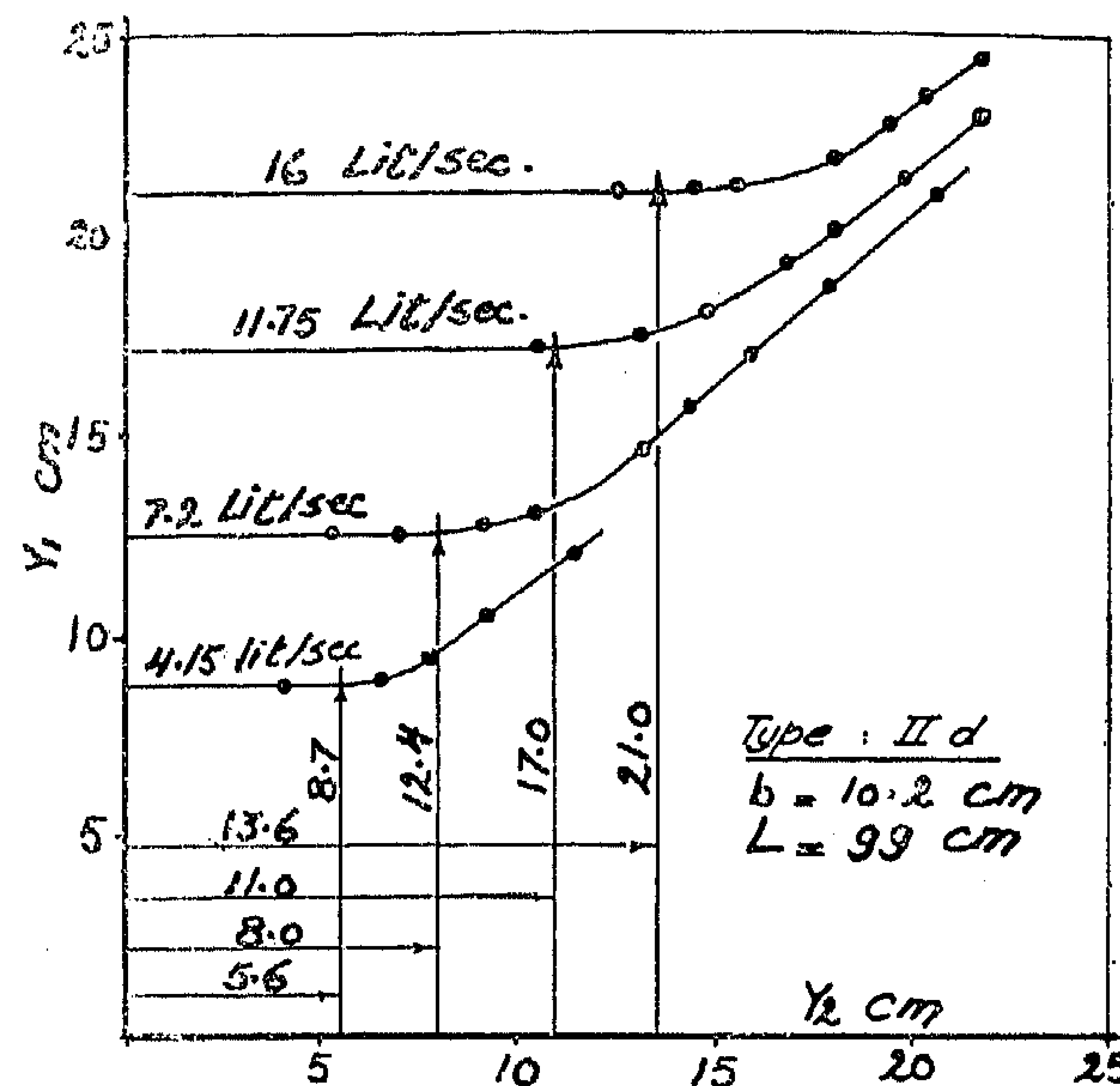
(FIG 13)

Summary and Conclusions

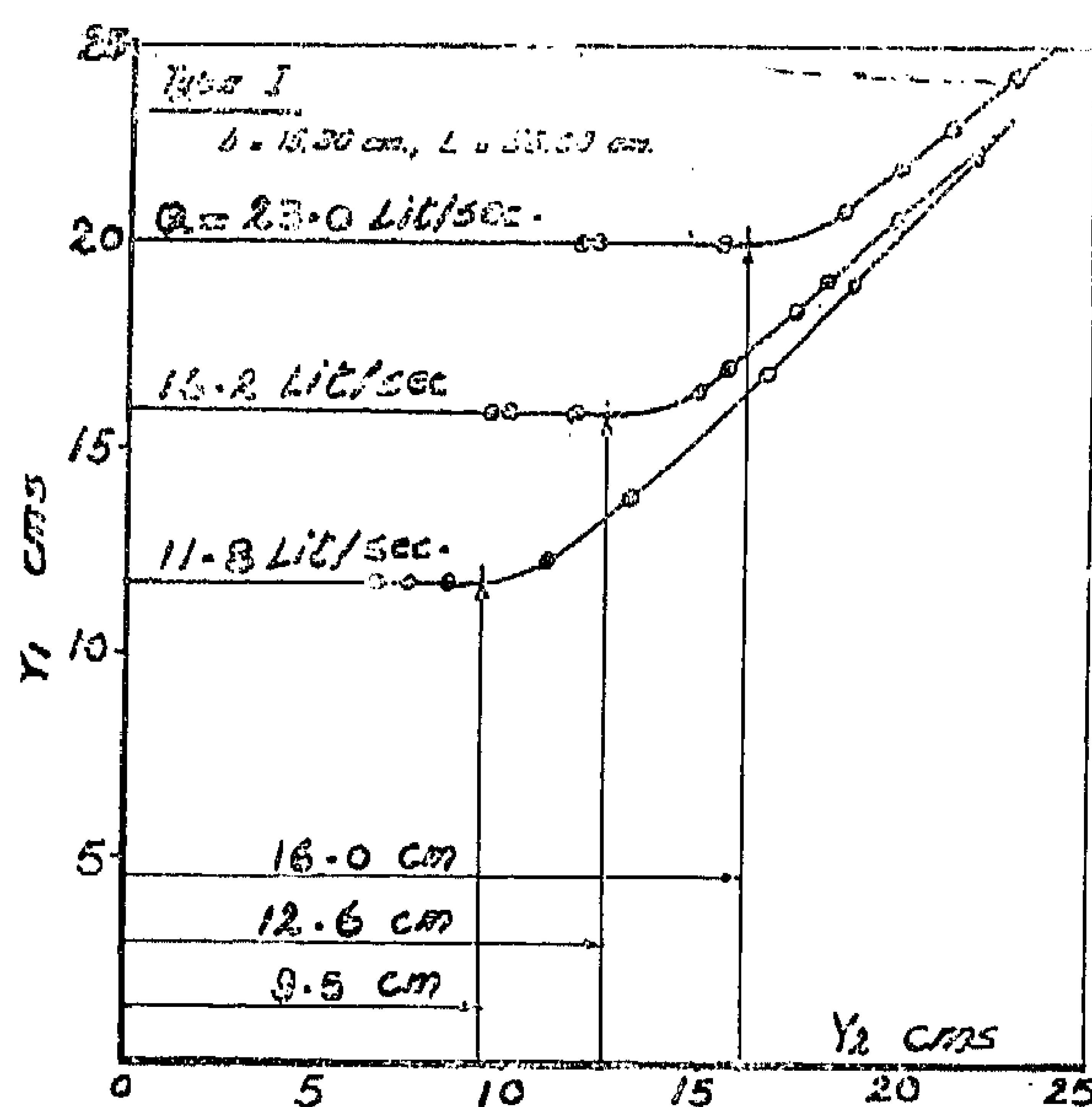
In various water structures such as regulators and bridges, the cross sectional area of flow is restricted at some sections by the construction of piers and walls to form a number of vents through which the flow takes place with a free surface. The present work is aimed at obtaining some detailed knowledge of the various parameters associated with the flow through such vents. An analytical approach based on energy principle was tried together with another approach based on mo-



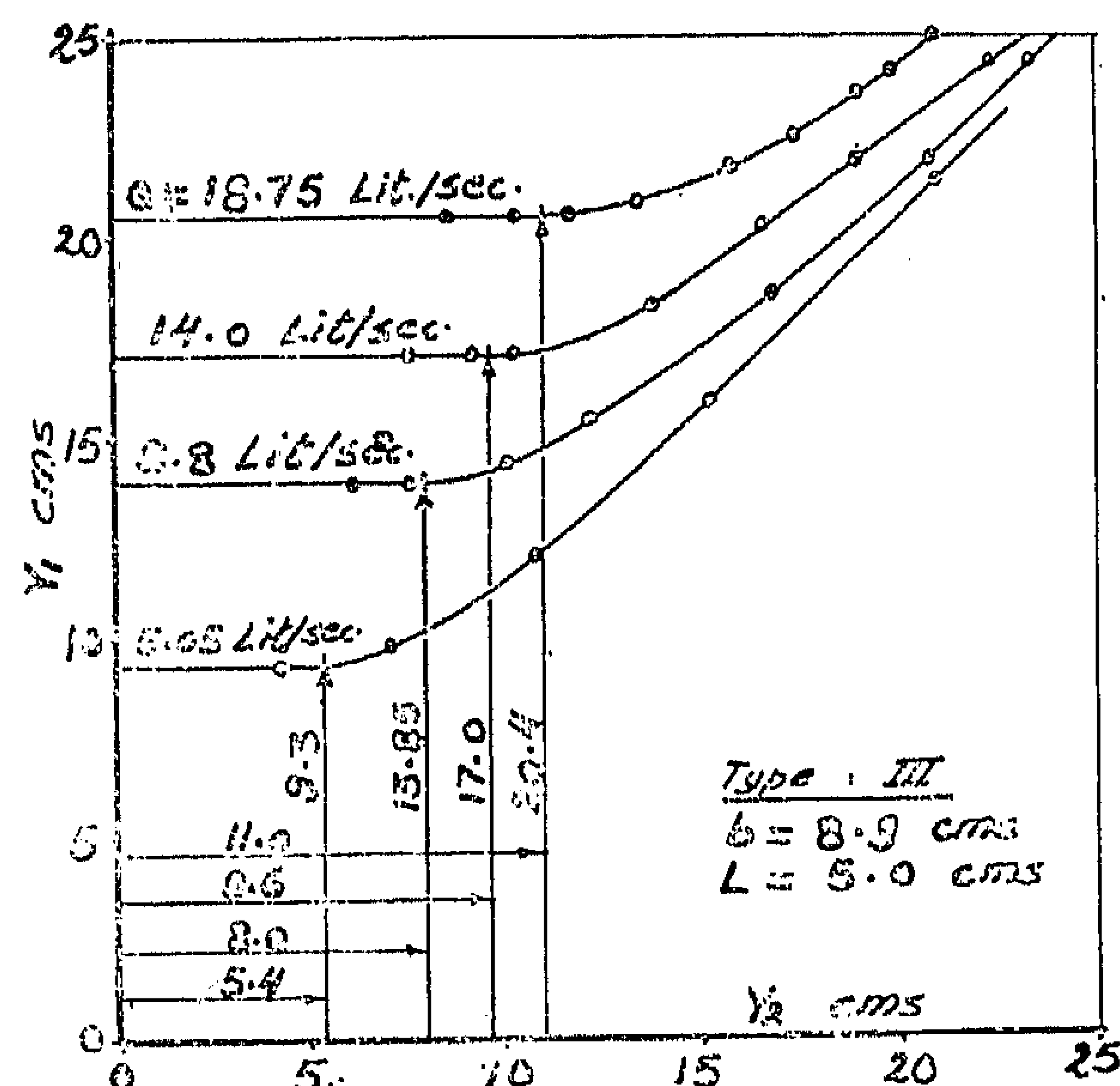
(FIG. 8)



(FIG. 10)

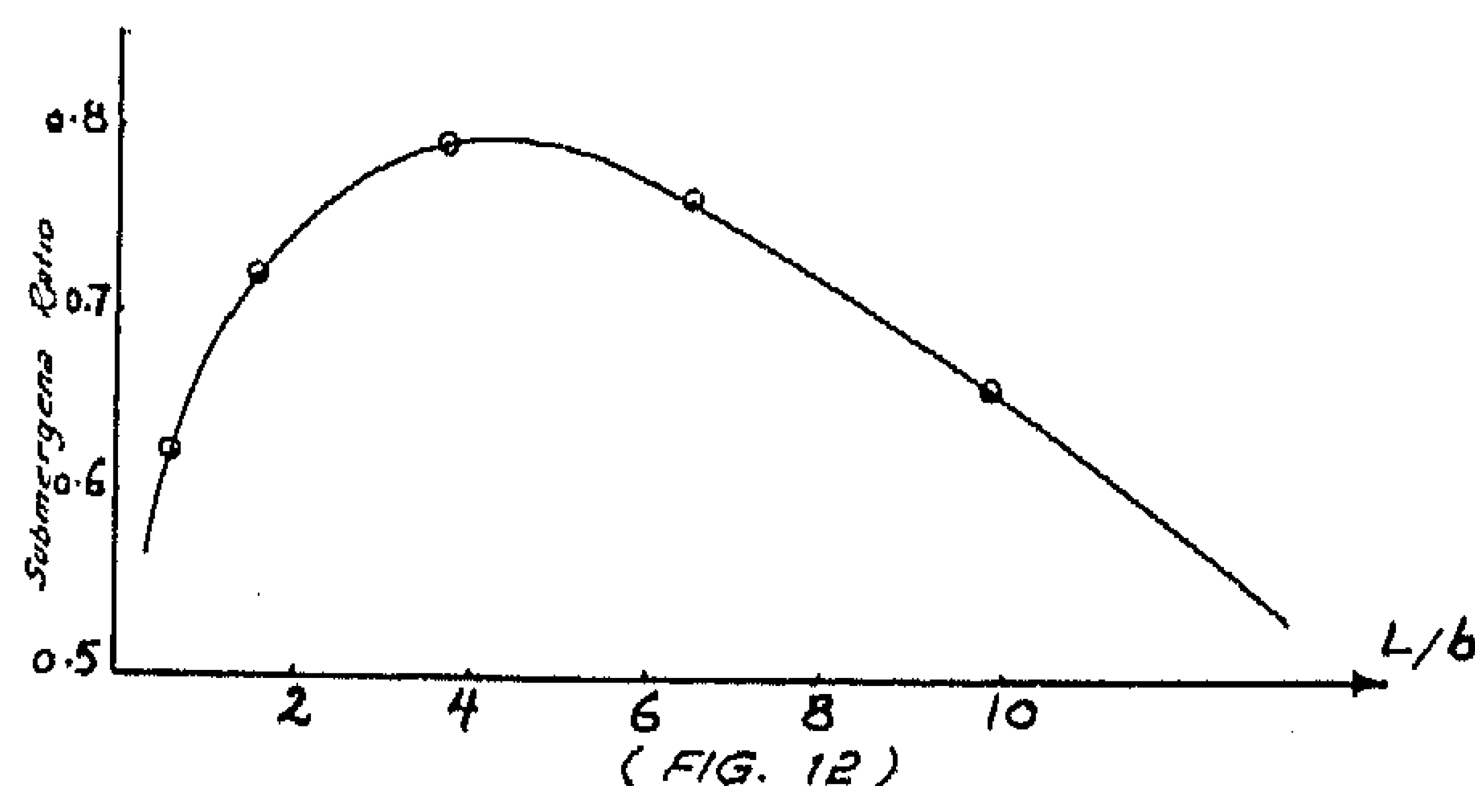


(FIG. 9)



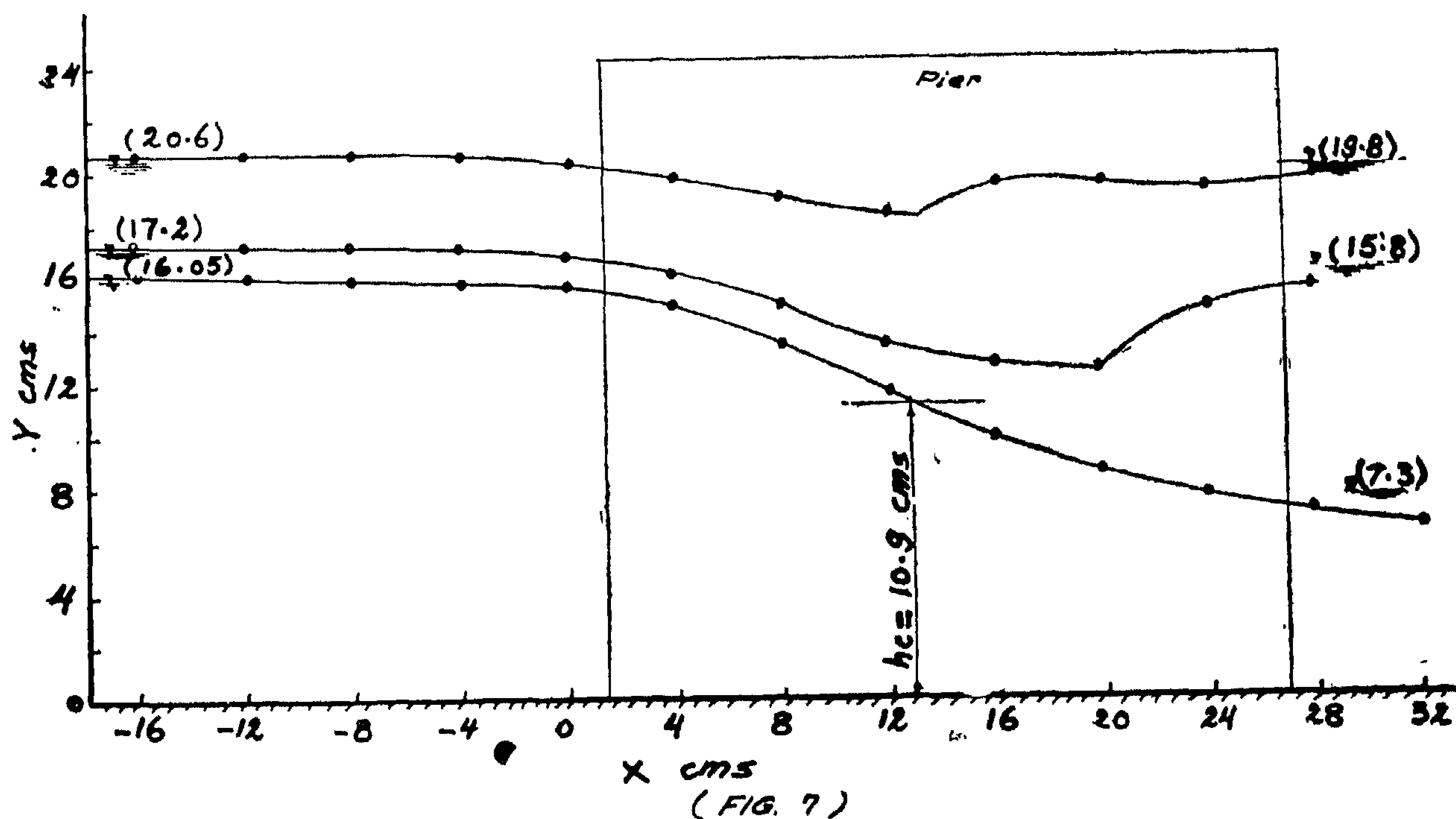
(FIG. 11)

note that figure (12) revealed that the maximum submergence ratio of about 0.8 is obtained with L/b ratios around 4.0. Increasing the ratio of pier length to vent width results in a decrease in the submergence limit, though at much smaller rates than the case when decreasing the L/b ratio. Therefore the value L/b of about 4.0 is recommended in the design of regulators and smaller values should be avoided.



(FIG. 12)

Adopting equation (6) as a basis for



(FIG. 7)

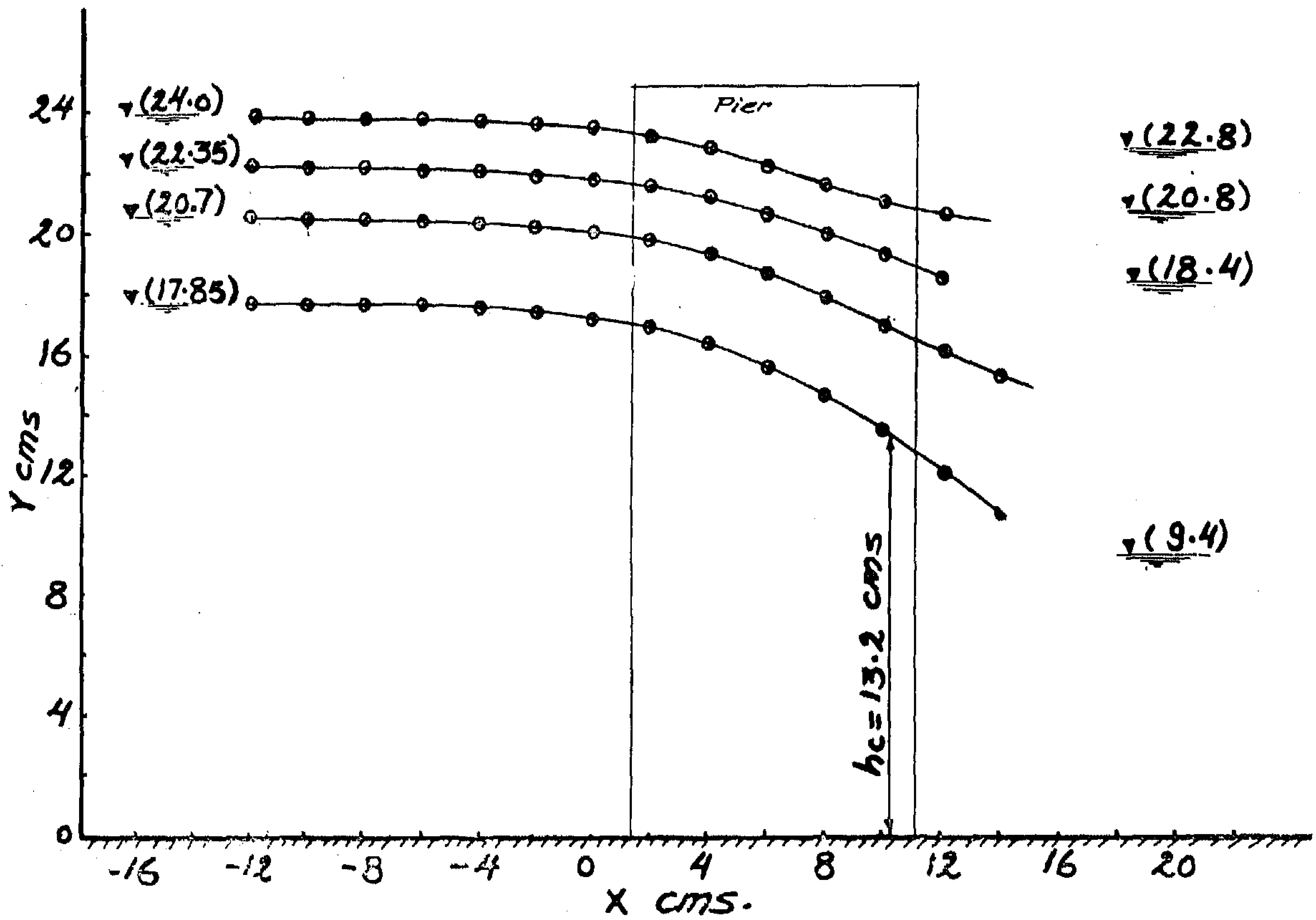
Geometrical properties of series

Series	b cms	r cms	L cms	b/B	L/b
I a	15.3	2.5	7.2	0.413	0.472
I b	15.3	2.5	23.0	0.413	1.505
I c	15.3	2.5	58.0	0.413	3.790
I d	15.3	2.5	99.0	0.413	6.470
II a	10.2	2.5	7.2	0.274	0.706
II b	10.2	2.5	23.0	0.274	2.255
II c	10.2	2.5	58.0	0.274	5.680
II d	10.2	2.5	99.0	0.274	9.720
III	8.9	5.0	5.0	0.24	0.562

various runs made and typical plots of these are shown clearly in figures (9 to 11) which show clearly the range of both submerged and free flow in each case.

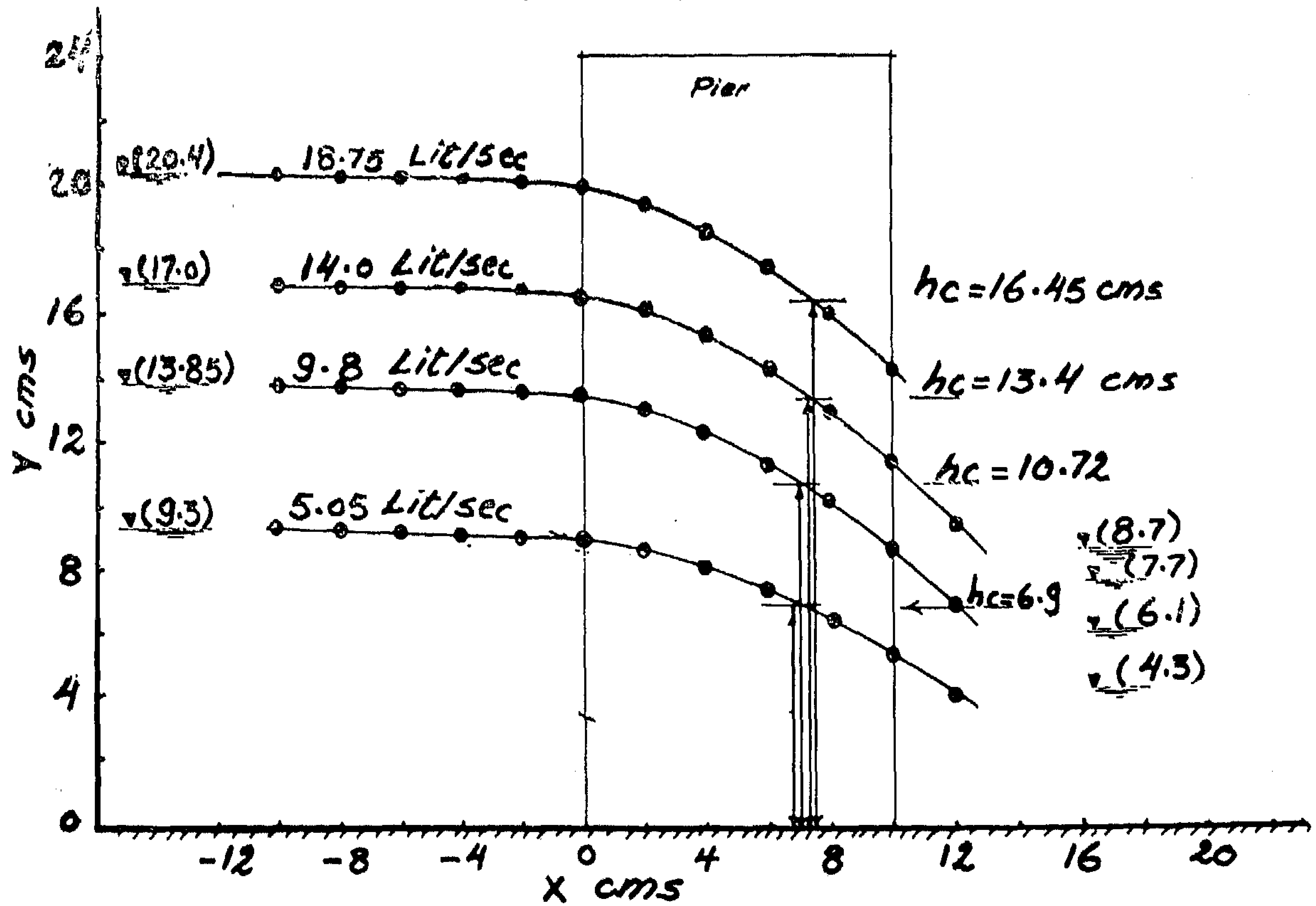
As seen from the figures, the upstream water depth is unaffected by the downstream water depth up to a certain value and after which, raising the downstream depth necessarily affects a corresponding increase in the upstream water depth. This is seen clearly from all plots. This critical limit is called the submergence limit, and it is interesting to note that this submergence limit is almost constant for each particular ratio of L/b as can be seen from figures (8 to 11) whatever the value of discharge or of upstream water depth. This maximum submergence limit was then plotted against the ratio of pier length to vent width L/b as shown in figure (12). It is very interesting to

Series I (b = 15.3 cms, L = 9.7 cms, Q = 23 Lit./sec.) Submerged Flow



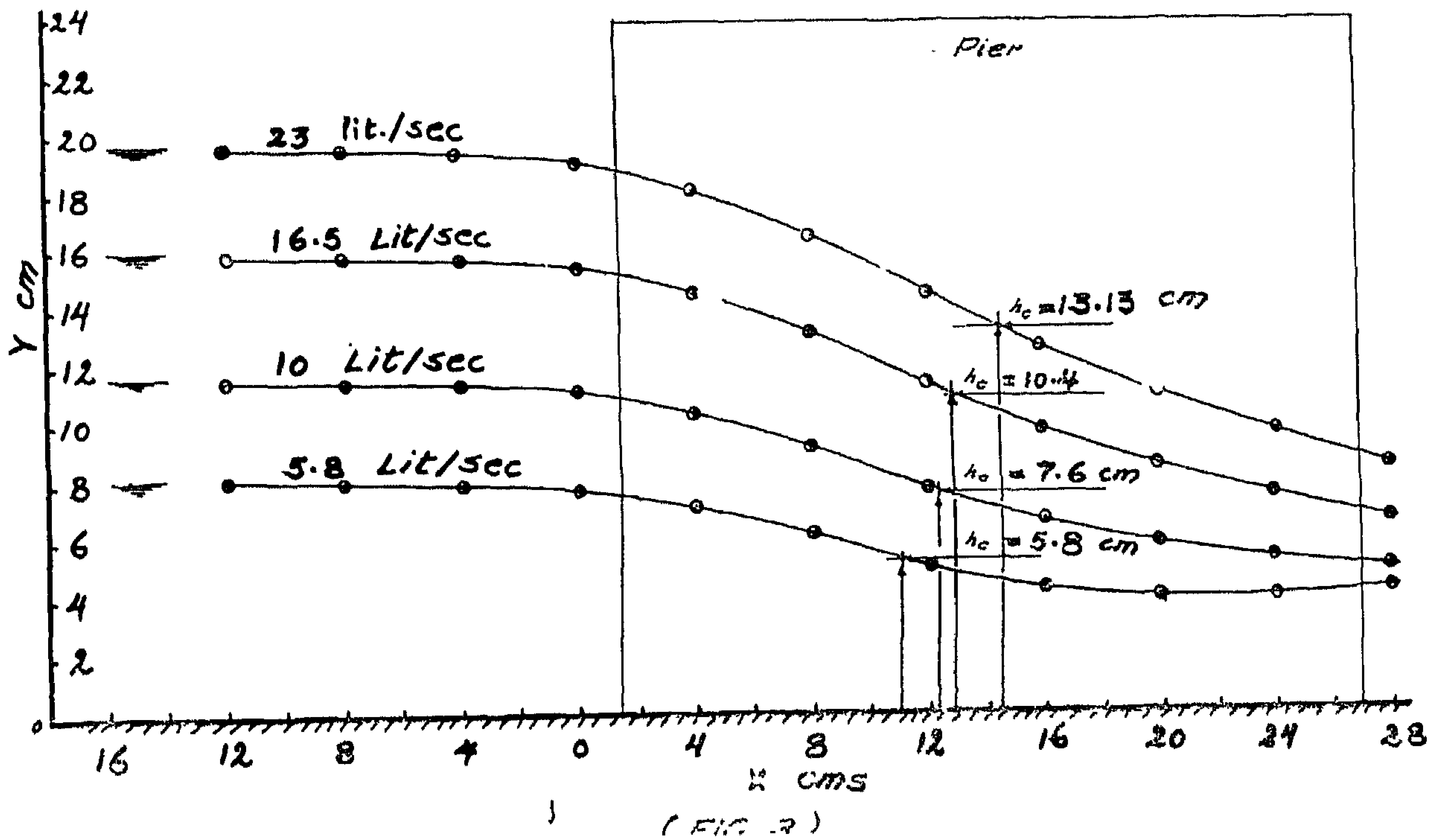
(FIG 5)

Series III (b = 8.9 cms., L = 5 cms) Free Flow



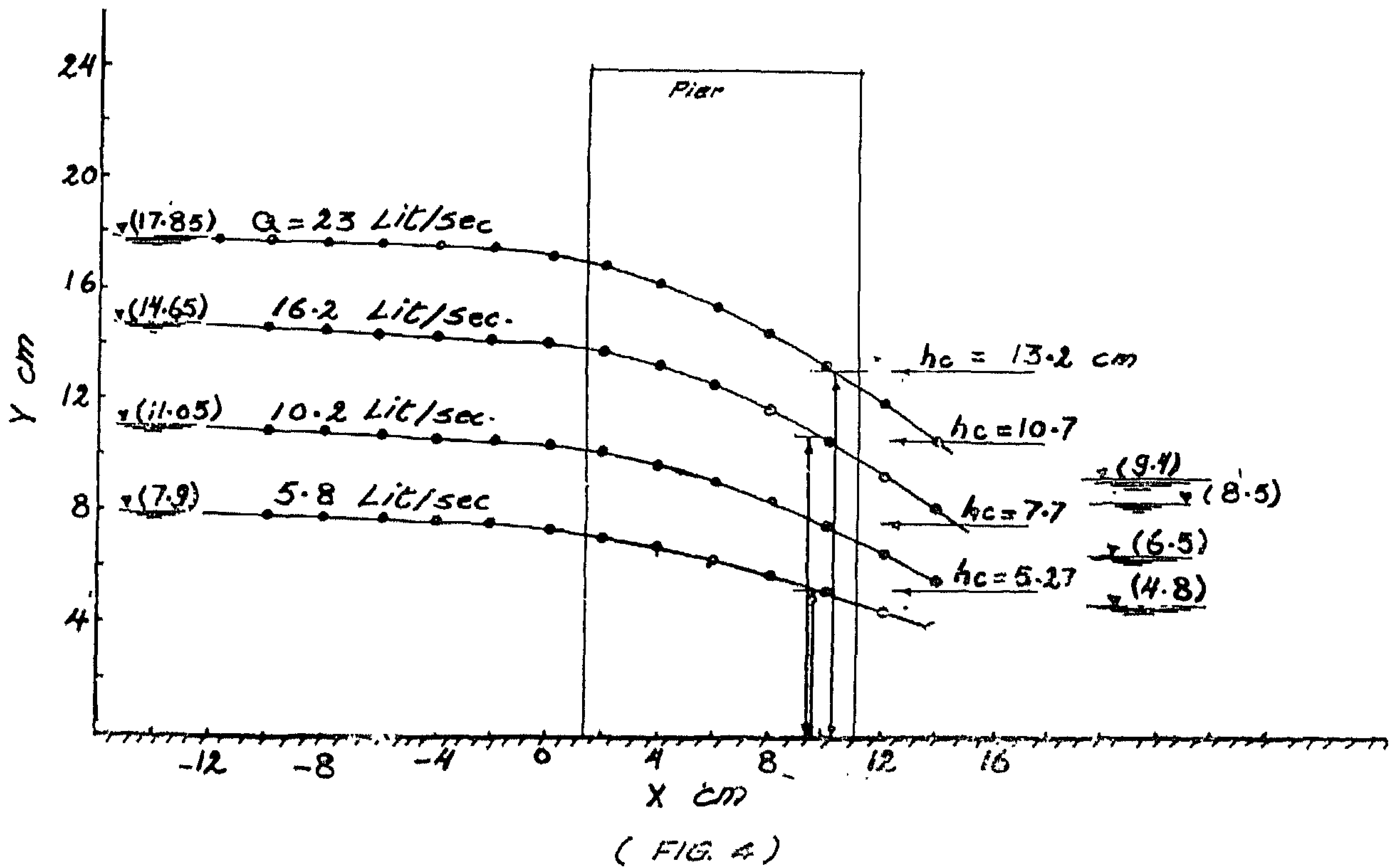
(FIG. 6)

Series I (b = 15.3 cms., L = 25.5 cms.) _ Free Flow



(FIG. 3)

Series I (b = 15.3 cms., L = 7.2 cms.) _ Free Flow



(FIG. 4)

The effect of adopting Y_1 in the equation instead of $(Y_1 + V_1^2/2g)$ and of neglecting friction losses are included in the factor $\bar{c}$.

Experimental set up and results

A very long flume, 37 cms bed width and 24 cms depth was used. Rails for mounting the carriage carrying the point guage were provided on top of the flume sides. Water supply was fed to the flume through a 8", diameter pipe and provisions were made to have steady well established uniform flowat the measuring portion of the flume. This was achieved by a system of screens, gravel filters and stream lined transitions at entrance and alos by mounting the experimental models at a section in the flume 10 meters downstream the entrance to allow full establishement of flow.

The downstream flow conditions were controlled by a vertical tail gate operated by a screw with a fine thread for precise adjustment. The flow was measured using a well calibrated 8" venturimeter mounted on the feed pipe and connected to a diffrential mercury manometer. Water levels were measured using a point guage provided with a vernier.

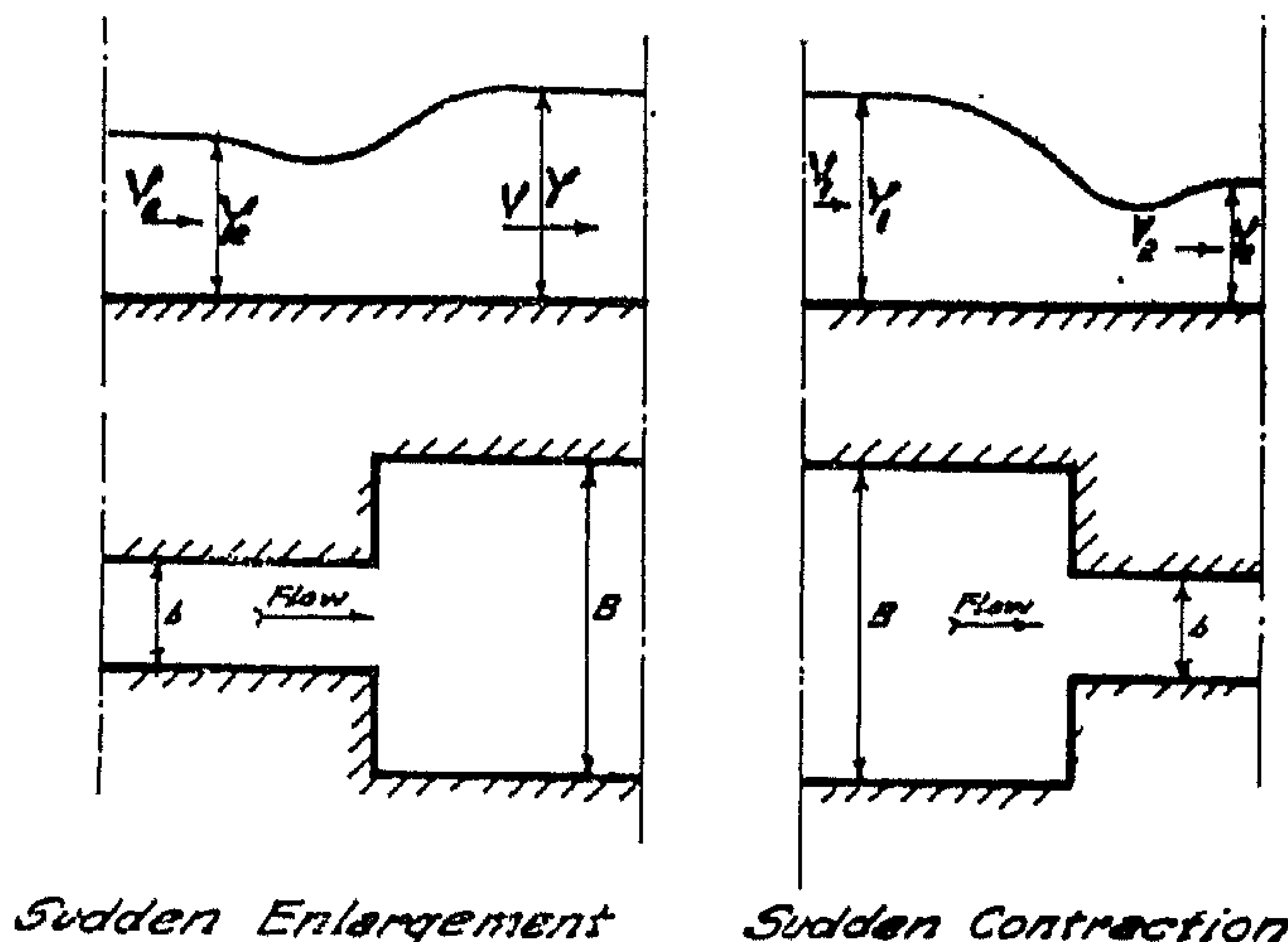
The vents used were formed withen the flume's bed width by using two identical piers fixed to the sides of the flume (figure 1), and various vent widths and pier lengths were used. The vent width b was varied between 8.9 cms and 15.3 cms thus giving a b/B ratio between 0.24 and 0.413. The pier length was varied between 5 and 99 cms, thus giving a L/b ratio between 0.472 and 9.72, i.e., about 20 times fold range. The inlet and outlet edges of piers were rounded to a radius of curvature that varied between 2.5 and 5 cms.

Three main series of experiments were undertaken, the first series (series I) with a vent width b of 1.3 cms, the second series (II) with a vent width of 10.2 cms and the third series (III) with a vent width of 5 cms. The radius of curvature r for inlet and outlet edges was adopted to be 2.5 cms for the first two series, and 5 cms for the third series. In each of the first two series, 4 different pier lengths of 7.2, 23.0, 58.0 and 99 cms respectively were tested, whereas the single length of 5.0 cms was tested in series III.

For each particular vent opening, and each particular pier length, various discharges varying between 4.5 litres/sec and 23 litres/sec were allowed with both free and submerged downstream conditions. Altogether 220 different experiments were used and a complete survey of water surface profile was made in 81 of these experiments. The following table gives the gecmetrical properties of the various experimental series whereas figures (3 to 7) give typical water surface profiles.

In figures (3 to 7) which show 19 different water surface profiles out of the 81 profiles measured in the present experiments, the critical depth h was calculated for the vent and was included in the figures for comparison.

On the other hand, the upstream water depth Y_1 was then plotted against the waterdepth withen the vent Y_2 for the



(FIG. 2)

Another approach to the treatment of losses through vents may be found in considering the constriction as a venturiflume. According to figure (1) and from Bernolli's equation, neglecting friction, we get :

$$Y_1 + \frac{V_1^2}{2g} = Y_2 + \frac{V_2^2}{2g}$$

$$\therefore (V_2^2 - V_1^2) = 2g(Y_1 - Y_2)$$

but, $Q = A_1 V_1 = A_2 V_2$

Substituting, thus :

$$Q^2 \left(1 - \frac{A_2^2}{A_1^2}\right) = A_2^2 \times 2g(Y_1 - Y^2)$$

or

$$Q = \sqrt{\frac{2g}{1 - (\frac{A^2}{A_1})^2}} \times A_2 \sqrt{\triangle h}$$

$$\therefore Q = M A_2 \sqrt{\triangle h} \qquad (5)$$

Introducing a correction factor c to account for friction and turbulence losses and also for convenient use, by considering the difference in water depth appearing below the square root in equation (5) to be the difference $\triangle Y$, between upstream and downstream water depths ($\triangle Y = Y_1 - Y$).

Equation (5), can thus be written :

$$Q = c\,\mathbf{M}\,A_2 \sqrt{\triangle Y} \qquad (6)$$

where, $\mathbf{M} = \sqrt{2g / (1 - \frac{A^2_2}{A^2_1})}$, A_1 and A_2 are the cross sectional areas of flow in channel and vent respectively,

$A_1 = B.\,Y_1$ and $A_2 = b.\,Y_2$

On the other hand if h_c is the critical depth which is assumed to occur withen the vent, and if losses are neglected between upstream section and the section of critical depth, (i.e. before jump is formed), then applying Bernolli's equation, we get:

$$Y_1 + \frac{V_1^2}{2g} = h_c + \frac{V_c^2}{2g}$$

But since it is well established that for rectangular channels.

$$V_c^2 / 2g = \frac{1}{2} h_c ,$$

thus:

$$Y_1 + \frac{V_1^2}{2g} = \frac{3}{2} h_c = H_{total} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(7)$$

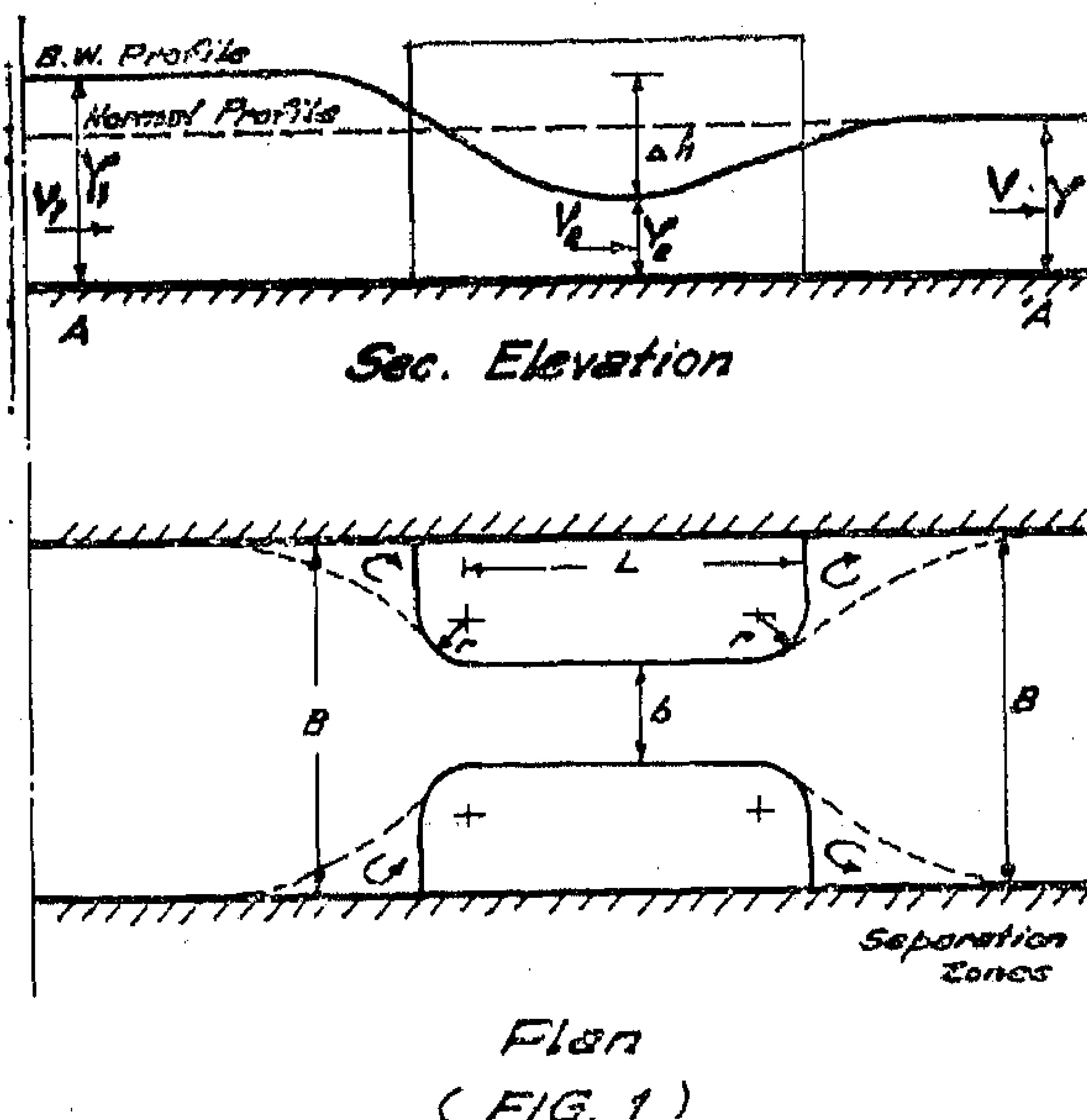
$$\text{but } Q = V_c \times b \times h_c = b \cdot h_c \cdot \sqrt{g\,h_c} = b\sqrt{g}\; h_c^{3/2} \quad \ldots\ldots(8)$$

From (7) & (8), then:

$$Q = b \cdot \sqrt{g} \cdot (2/3)^{3/2} (H_{total})^{3/2}$$

Or,

$$Q = 1.703\; b\,(H_t)^{3/2} = \bar{c}\; b\,(Y_1)^{3/2} \quad \ldots\ldots\ldots\ldots(9)$$



(FIG. 1)

separation zones are formed upstream of the piers and which are occupied by eddying water dissipating particular amounts of energy. Similarly, after the flow leaves the vent of width b and expands to the full width B of the channel, separation zones are formed in the vicinity downstream of the piers with a corresponding eddying motion and consequent loss of energy.

The entrance to the vent and the exit out of it may be treated as sudden contraction and sudden enlargement respectively and accordingly the energy losses at the two zones may be expected to resemble energy losses for the sudden contraction and sudden enlargement respectively. Withen the vent itself additional energy losses are expected due to friction depending upon the length L of vent, bed width b and minimum depth Y_2 .

If h denotes the head loss due to turbulence engendered in the upstream separation zones, h' denotes the eddy loss in the downstream separation zones, and h_f denotes the head lost by friction withen the vent, thus the total loss H is written :

$$H = h + h_f + h' \quad \dots\dots\dots\dots (1)$$

Assuming the channel floor to be horizontal or nearly so in the zone of piers and adopting it as an arbitary refrence plane, which by applying Bernolli's equation (principle of conservation of energy) between points A and A' we get :

$$y_1 + v^2_1/2g = y + v^2/2g + H \text{ or}$$
$$H = (y_1 - y) + 1/2g\cdot (v_1^2 - v^2) \quad (2)$$

Consider the sudden enlargement and sudden contraction shown in figure (2) and applying the momentum principle respectively, thus :

For sudden enlargement we have :

$$\rho\, Q (v-v_2) = g/2 . (b.y^2_2 - B\cdot y^2)$$

ut from continuity equation, $Q = b.\, Y_2 . v_2 = B.Y.V$

$$\therefore 2\, by_2v_2\left(\frac{b\, y_2v_2}{B\ Y} - v_2\right) = g(y^2_2 - y^2)$$

which is readily reduced to :

$$F^2 = \frac{(y_2/y) [y_2/y)^2 - 1]}{2 [(y_2/y) - B/b]} \text{ Where } F^2 = \frac{v^2}{gy} \quad (3)$$

also for sudden contraction we habe :

$$\rho\, Q (v_2 - v_1) = g/2 . \mathbf{B} (y_1^2 - y_2^2)$$

and from continuity, thus, $Q = B.Y_1 . V_1 = b.\, Y_2 . V_2$

$$\therefore 2\, b.y_2.v_2 (v_2 - v_1) = g\, \mathbf{B}(y^2_1 - y^2_2)$$

which can be reduced to :

$$F_2^2 = \frac{(B/b) (Y_1/Y_2) [(Y_1/Y_2)^2 - 1]}{2 [(Y_1/Y_2) - b/B]}$$

where $F_2^2 = V_2^2/g\, Y_2$ (4)

Equations (3) & (4) give distinct relations for the ratio of water depth before, withen and after the vent together with the ratio of bed widths and the relevant Froude's number. However, equations (3) & (4) being derived from Momentum Principle do not reflect any light on the procedure of energy distribution in the flow; and therefore, equations (1) & (2) still offer more convenient means for estimation of energy losses. The total head loss H (equation 2), can be therefore determined experimentally.

EXPERIMENTAL AND ANALYTICAL INVESTIGATION FOR THE FLOW THROUGH VENTS OF WATER STRUCTURES

By

Dr. Aly I. EL-GAWHARY

B. Sc, D.I.C., Ph.D.

INTRODUCTION :

In many water structures built in open channels such as regulators, bridges, aqueducts, ... etc., the cross sectional area of flow is reduced at some sections by the construction of piers or walls to form a number of vents through which the flow takes place with free surface. Further downstream, the flow expands again to the full cross sectional area of the channel with necessarily modefied depths and with expectedly smaller energies than those originally prevailing before the flow passes through vents. In most practical cases the channel is prismatic and has a mild slope and consequently the presest investigation will limit it self to the flow in a rectangular channel in a subcritical state.

Irrigation engineers usually concern themselbes with only the overall picture of the flow before and after entering the vents and thus try to estimate the energy lost in the constriction using formulae of purely emperical nature. The head lost and the heading up resulting are often estimated in terms of the ratio between the constricted area and original area, the velocity of approach and finally some emperical coefficients. However, these emperical formulae have their own limitations to the range in which they were derived. A more detailed study for the flow through vents becomes of urgent importance for a more refined and detailed knowledge of the changes taking place in the flow as it passes through the vents. Accordingly the present work is aimed at obtaining such detailed knowledge on the various flow parameters associated with constrictions formed by piers and walls of water structures.

Analytical Considerations:

Consider the vent shown in figure (1), where the bed width changes from B to b withen the vent and then to B again after it leaves the vent. The length of the vent is L and the radius of curvature of the piers is r both at inlet and outlet of vent. As the flow approaches the vent, a backwater curve of Ml type profile is first developed upstream from the vent, thus a flow depth Y_1 greater than the normal depth Y is reached just upstream of the vent and where the velocity is V_1. Withen the vent the flow is rapidely varied, characterized by marked acceleration in directions both normal and parallel to t ehstreaw lines. Due to the reduction in cross section, the depth is reduced to a minimum Y_2 and the velocity is increased to a maximum V_2 .

After leaving the vent, the flow expands suddenly to the downstream section of the channel where the uniform flow regime is reastablished in the full-width channel and where the normal depth is Y and corresponding norwal velocity V.

In the vicinity upstream the vent, as the flow contracts to the width of vent b,

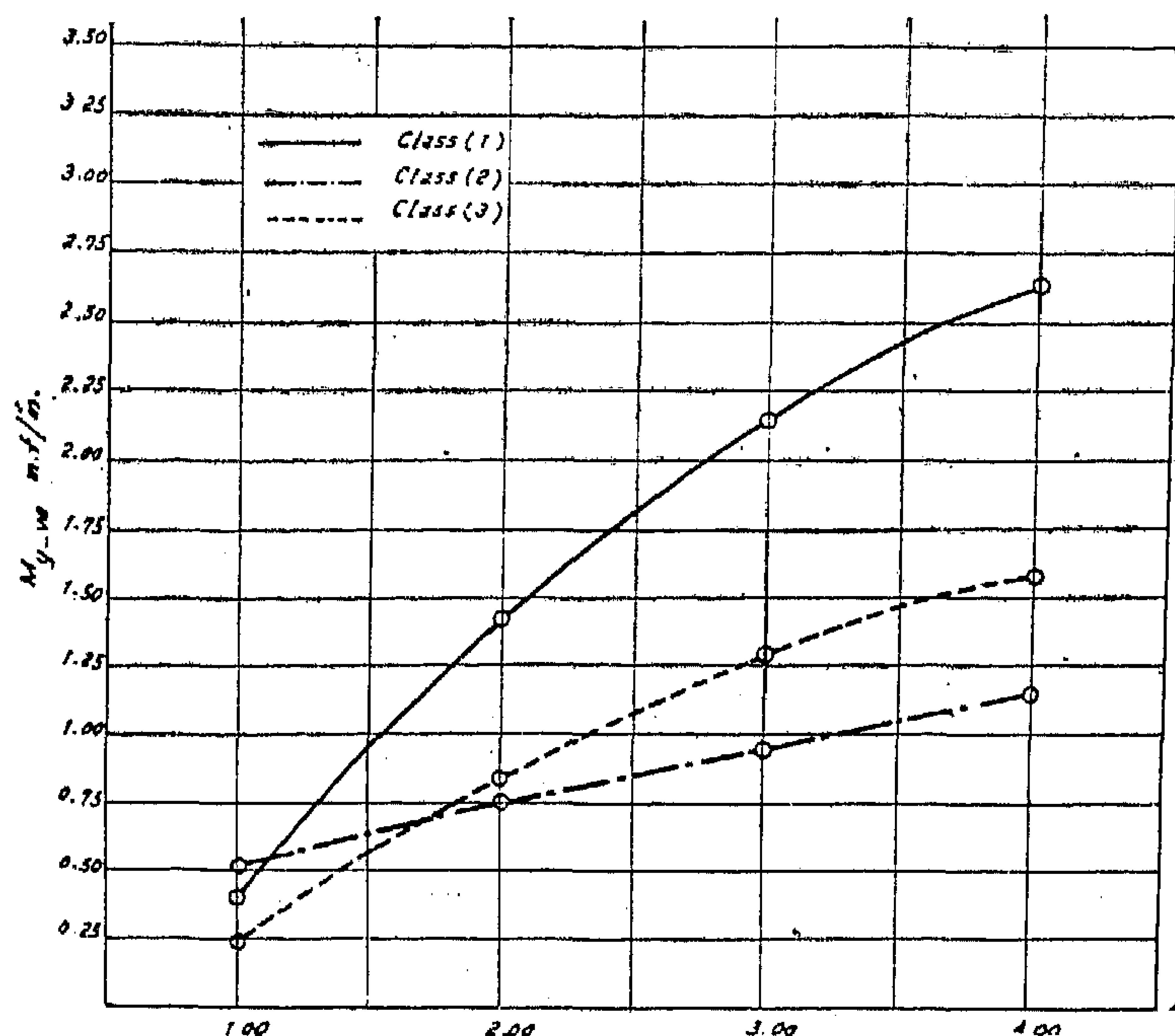


Fig.(19) : Curve for the edge quarter of a square plate with two continuous edges meeting at a corner.

easily used for any continous rectangular plates by replacing the values of unit rotation angles, boundary stiffnesses, carry over factors and side ratio by the proper values of the rectangular plate considered.

The developed influence surface charts reduce greatly time and effort for designers in obtaining the required bending moments compared with the classical methods for solving continuous plates. The loads are just to be put on the required influence surface chart, the final value of the required bending moment is directly obtained

Using the obtained curves relating bending momnts and side lengths of continuous square plates subjected to design loads according to the Egyptian Code of Practice for roadway bridges, the absolute maximum bending moment diagram could be directly drawn for both middle and quarter sections of the plate. Obtaining these values for positive and negative bending moments, helps in giving a good feature for the variation of bending momnts along the length of the plate.

8) **Refrences**

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5. El Shafey O.A. Bakki, "Analysis of Continuous Plates subjected to Concentrated Loads". Thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Civil Engineering, Faculty of Engineering, Cairo Univrsity, June 1973).

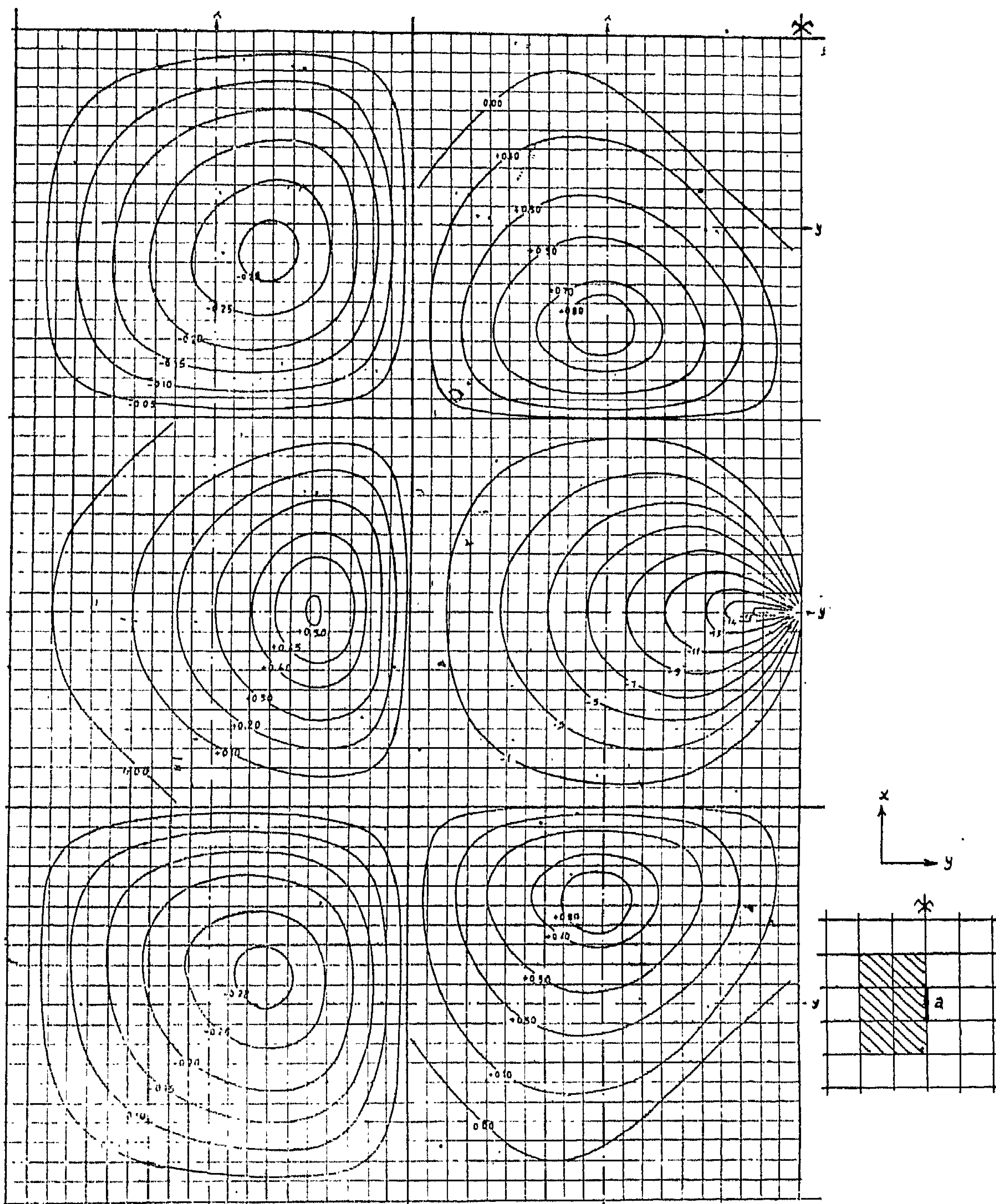


Fig. (18) : M_y - Support moment influence surface for the edge center of a square plate with four continuous edges and the effect of all the adjacent panels.
(multiplier factor 10^{-2}- times).

Note : The contour lines are symmetrical about the axis of symmetry.

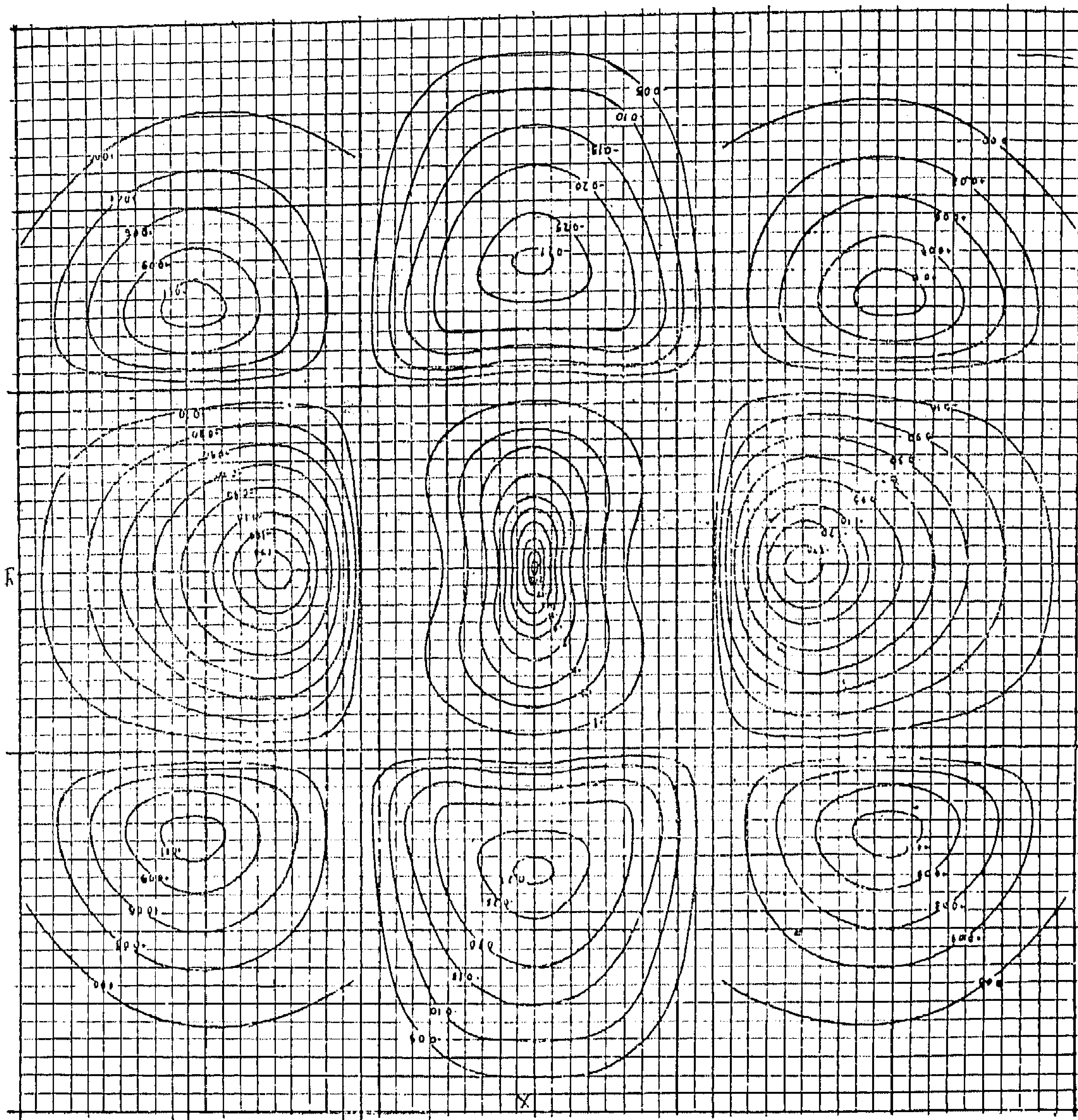


Fig. (17) : M_y - Influence surface for the center of a square plate with four continuous edges and the effect of all the adjacent panels. - (multiplier factor 10^{-2} - times).

cal position to give maximum value of the required moment. Several trails have to be made until the absolute maximum bending moment is reached. The effect of the adjcent panels is included in the given values (this effect does not exceed 10% from the final values in the studied cases.). This process is carried out for different side lengths 1, 2, 3 and 4 meters. These curves reduce the effort done by the designers to obtain the absolute maximum bending moments for each panel among a group of continuous square panels. Figure (19) shows a sample of these curves.

7) Conclusion

The general developed computer programme for determining the influence coefficients for bending moments in continuous plates could be

the developed influence surfaces and the corresponding cases of isolated plates given by Pucher (2), we find the following:

1) For negative moments at the middle and quarter points of the supporting edges, the influence coefficients of the continuous plates are 40% to 60% of those of isolated plates except for the region far from the reference point and near the opposite edge, the compared coefficients are near from each other and have very small values.

2) For positive moments at the middle and quarter points of the plate the influence coefficients of continuous plates are as follows :

   a) Very near to the reference point, the coefficients of continuous plates are 1.2 to 1.6 time those of isolated plates.

   b) Moving far from the reference point in both directions parallel and perpendicular to the direction of the moment the influence coefficients reach up to 2.5 time those of isolated plates.

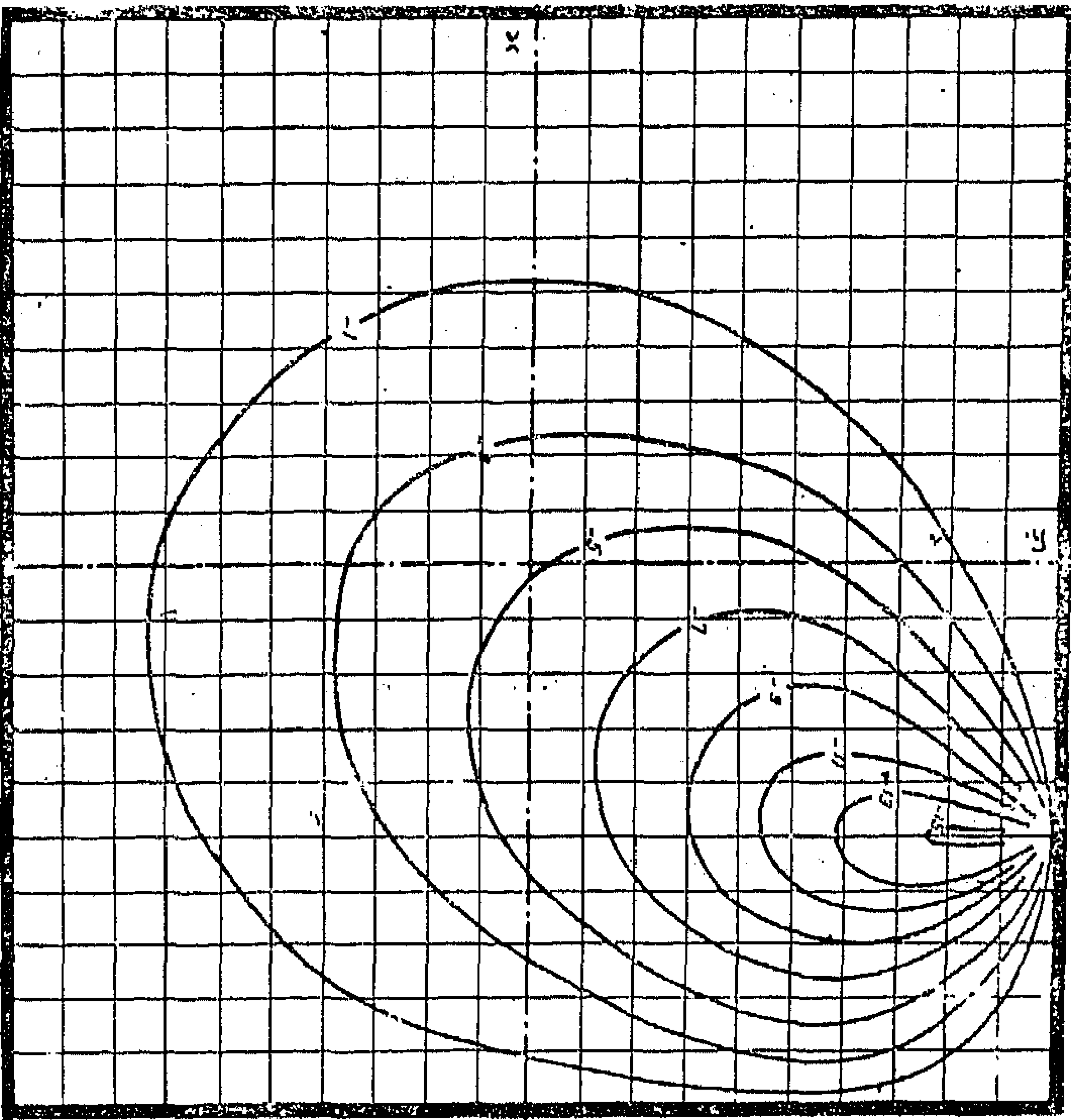
   c) For continuous plates which have one or more simply supported edges, the differnce between the influence coefficients of those plates and the corresponding coefficients of isolated plates is decreased. Very near to the simply supported edges, the coefficients for both the continuous and isolated are almost the same.

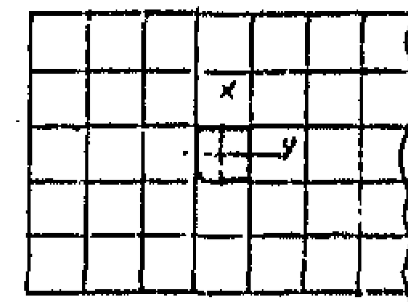
5.3.3.) Effect of Loading the Adjacent Panels on the Value of the required Bending Moment in the Studied Panel :

Not only the influence coefficients of the required bending moment in the studied panel are required, but also the coefficients of the effects of all the adjacent panels. The computer programme was developed in such a way that its output gives directly these coefficients. Figures (17) and (18) show two examples of the effect of loading the adjacent panels on the required bending moment in cases of positive moment an negative moment recpectively.

6) The Application of Obtained Influence Surfaces for Determination of Absolute Maximum Bending Moments According to Loads of Egyption Code of Practice for Roadway Bridges :

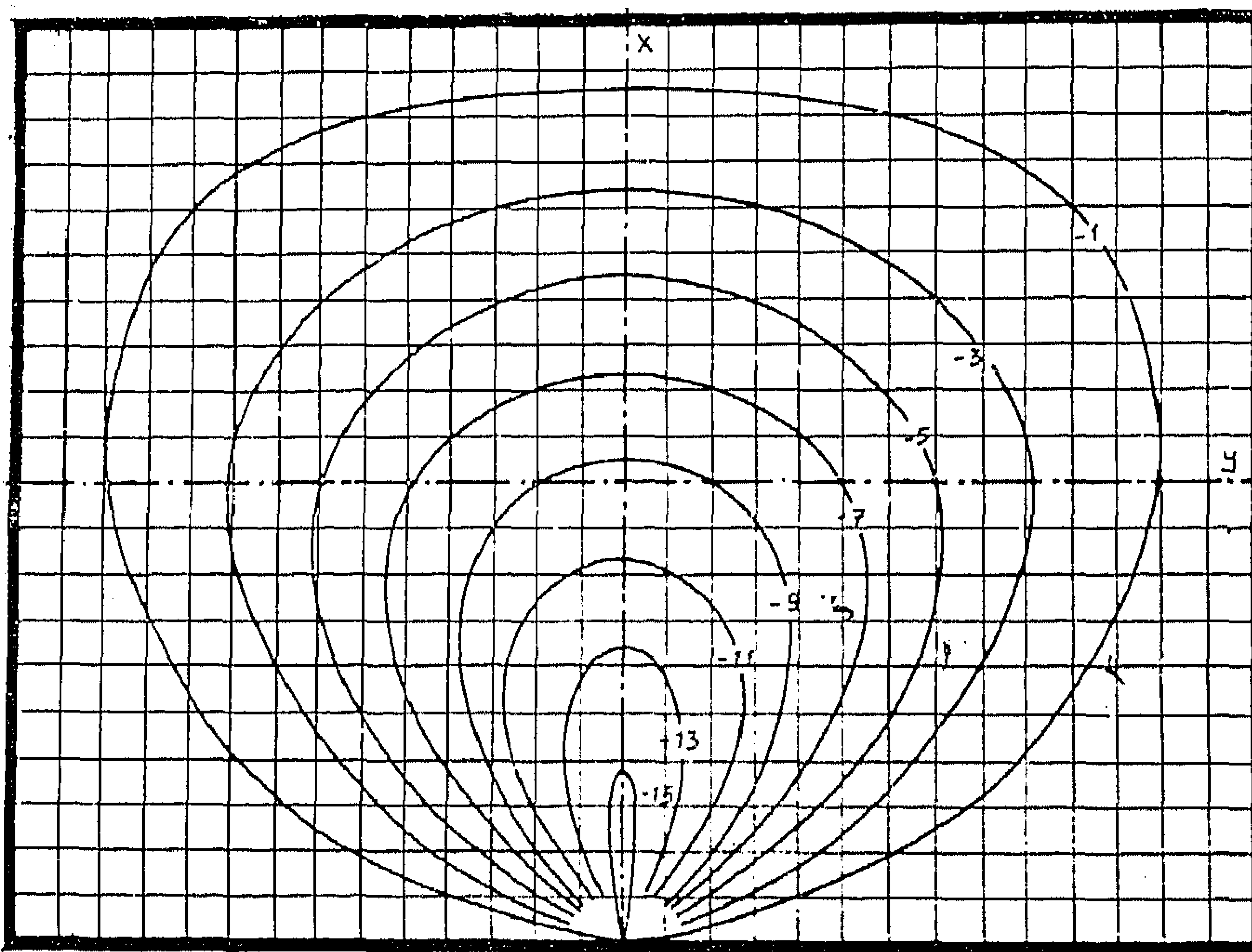
The basic idea of establishing curves relating bending moments at different points for various edge conditions and the side length of a square plate was inspired from the book "Fahrbahnplatten von Strassenbrücken', published by Rüsch in Berlin 1960. In this book Rüsch gave tables relating bending moments and the longer side length of rectangular continuous plates at different points for various edge conditions according to the design loads of German Code of Practice for roadway bridges. In order to obtain these tables, Rüsch treated the continuous rectangular plates by dividing them into strips of unit breadth and treating each strip as continuous beam in one direction. The treatment of the problem here is more exact because the effect of continuity is taken into consideration in all directions as illustrated in Brunner's method (3). The curves developed are computed for three classes of loading according to Egyptian Code of Practice for roadway bridges. In order to establish one of these curves as an example for square slabs, the loads are to be put on the influence surface chart of the studied moment at the required point (plate center, edge quarter, ... ect) in the expected criti-





Fig(15) :
M_y– Support moment influence surface for the edge quarter of a square plate with four continuous edges

(multiplier factor 10^{-2}– times)



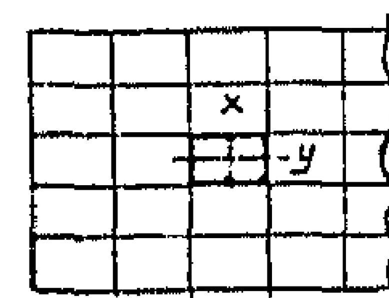


Fig.(16) :
M_x– Support moment influence surface for the longer edge center of a rectangular plate with four continuous edges.

(multiplier factor 10^{-2}– times)

5.3.2) <u>Comparison between the Developed Influence Coefficients and the corresponding Coefficients of Isolated Plates :</u>

ous plates in form of processes of distribution and carry over for the different continuous edges. The output of the programme gives the final values of the restoring rotation angles for different continuous edges from which the boundary moments could be calculated, hence the positive moments at middle and quarter points of the plate could be obtained. The output of the programme gives also the influence coefficients of the effect of loading the adjacent panels on the value of the required moment in the studied panel. This programme could be also used for any continuous rectangular plate by replacing the values of the unit rotation angles, bounndary stiffness, carry over factors and side ratio by the proper values of the rectangular plate considered. Also few stat ments are to be replaced by others if there is a certain diffierence in the boundary conditions.

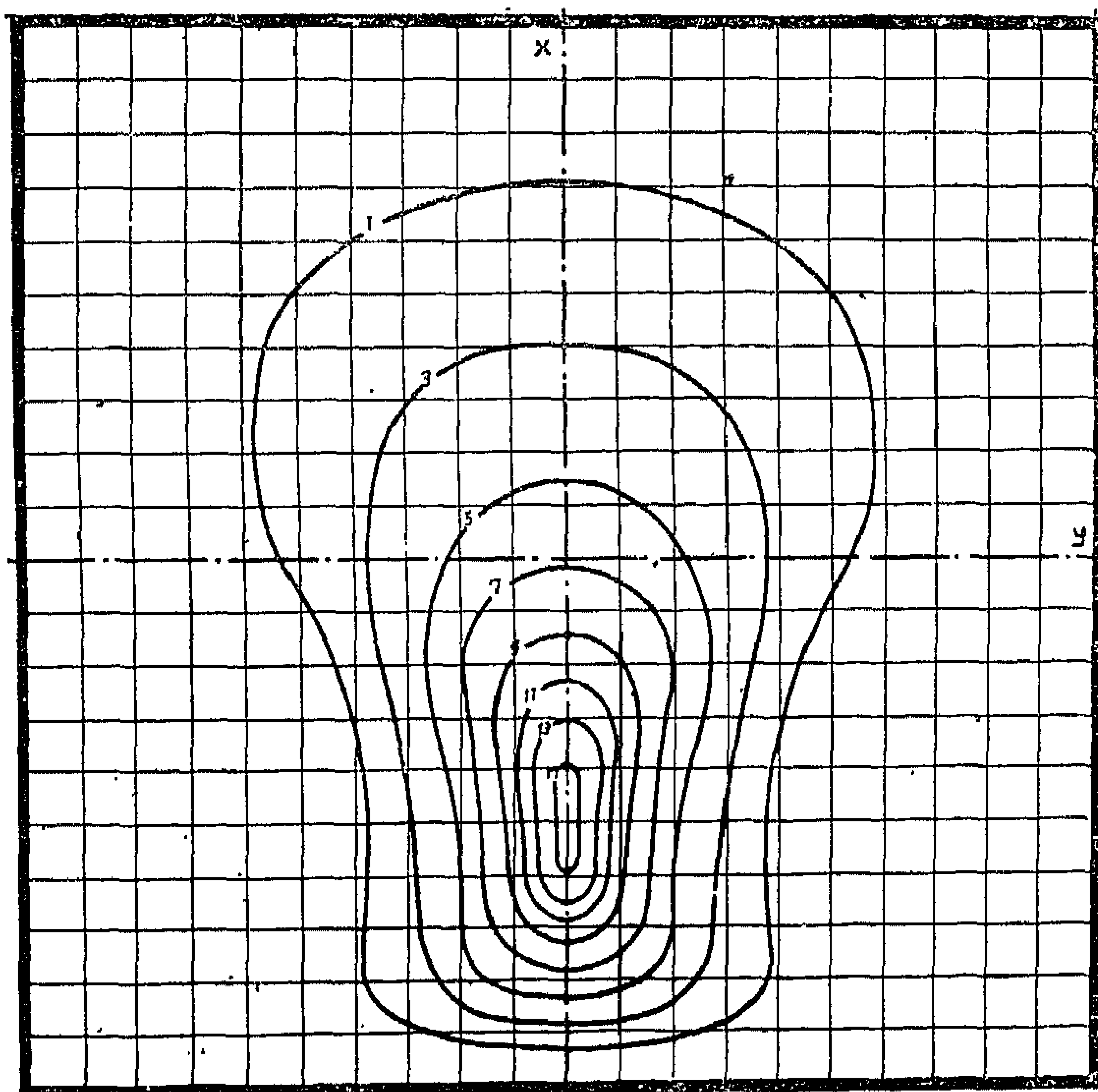
5.3) Comments on the Developed Influence Surfaces :

5.3.1) General Shape :

The most prominent feature of the developed influence surfaces for positive moments at center and quarter point of the plate is the high peak at the location of the moment. The surface drops off rapidly from that point and the steepest gradient being in the direction parallel to the direction of the moment (fig. 14). The developed influence surfaces for the negative momnets at the middle and quarter points of the support edge have a gentle slope along the whole plate except in the region surrounding the reference point (fig. 15). Figure (16) shows a sample of the obtained influnce surfaces for rectangular plates.

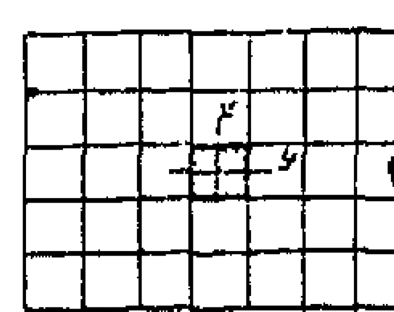
5.3.2) Comparison between the Developed Influence Coefficients and the corresponding Coefficients of Isolated Plates:

Comparing the influence coefficients of



Fig(14) :
M_y- Influence surface for the quarter point of a square plate with four continuous edges.

(multiplier factor 10^{-2}- times)



edge to this edge, as well as, the clamping conditions of the other three edges can be arbitrary. Because the boundary moments obtained from the correction influence area are small, it is sufficient to compensate these moments between the two sides of the studied edge proportional directly to the stiffnesses of the plates.

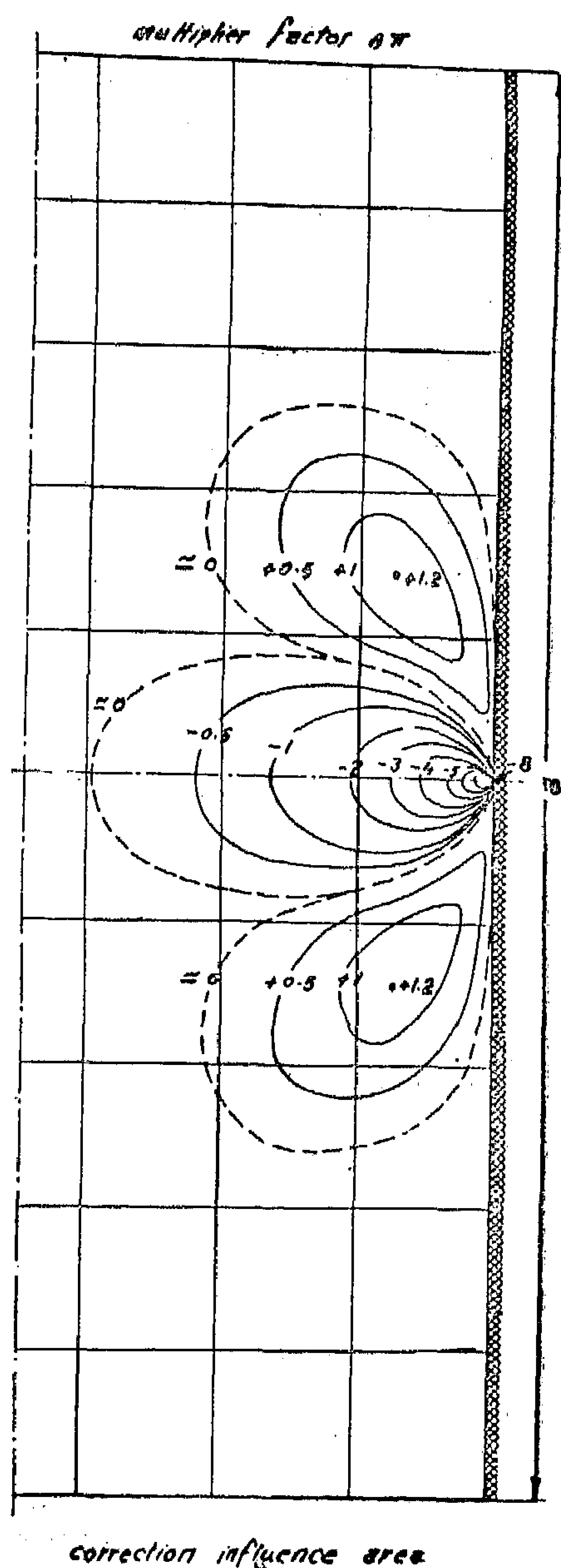


Fig. (13)

5) **Influence Surfaces for Bending Moments in Continuous Plates :**

5.1) **Basic Idea :**

The influence surface for continuous plates is calculated in a similar manner to that of isolated plates with the addition of the effect of continuity of all the adjacent panels. This was carried out using the distribution procedure given by Brunner(3) and explained before.

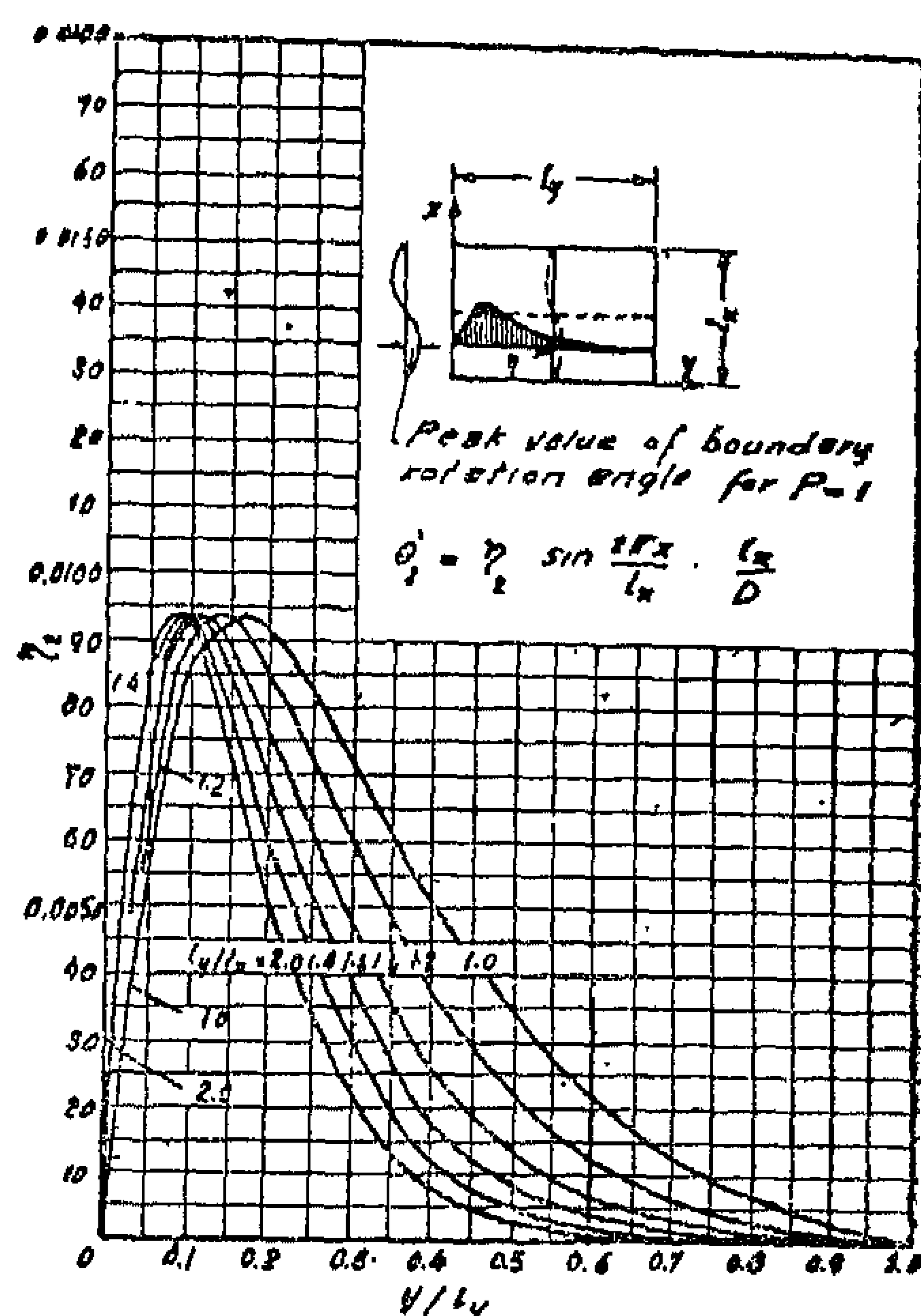
The plate is divided into a main grid of 19 x 19 (381 points), a unit load applied at each point and the bending moment is calculated at the required point for each case of loading. Also extra points near the reference point and near the plate edges were considered. Since the procedure needs a great effort according to the great number of cases of loading for each influence surface, it was convenient to carry out the calculations of the main grid using an electronic method.

Considering the different edge conditions, the above cases will be too much to be studied and compiled in one report. Different cases of square plates and samples of the rectangular plates are presented in the form of 35 charts (5). For each studied case the effect of loading the adjacent panels on the stuied panel is considered.

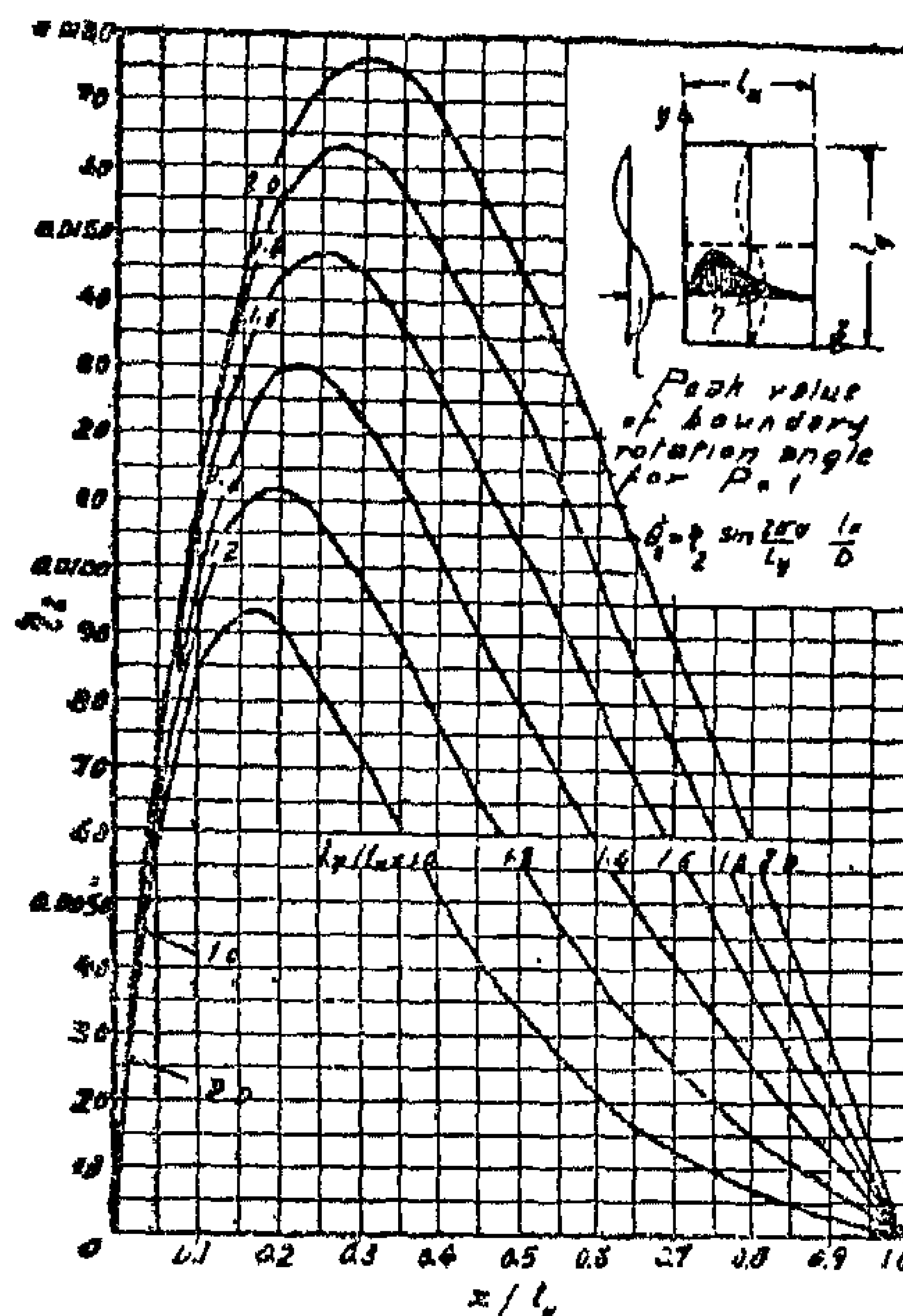
5.2) **Computer Programmes :**

A general computer programme (Fortran IV) is developed on the use of Brunner's method for solving continuous plates subjected to concentrated loads. The programme calculates the peak values of the angle of rotation curves of the plate boundaries due to a unit load at different grid points for simply supported cases. The programme includes the necessary calculations for solving continu-

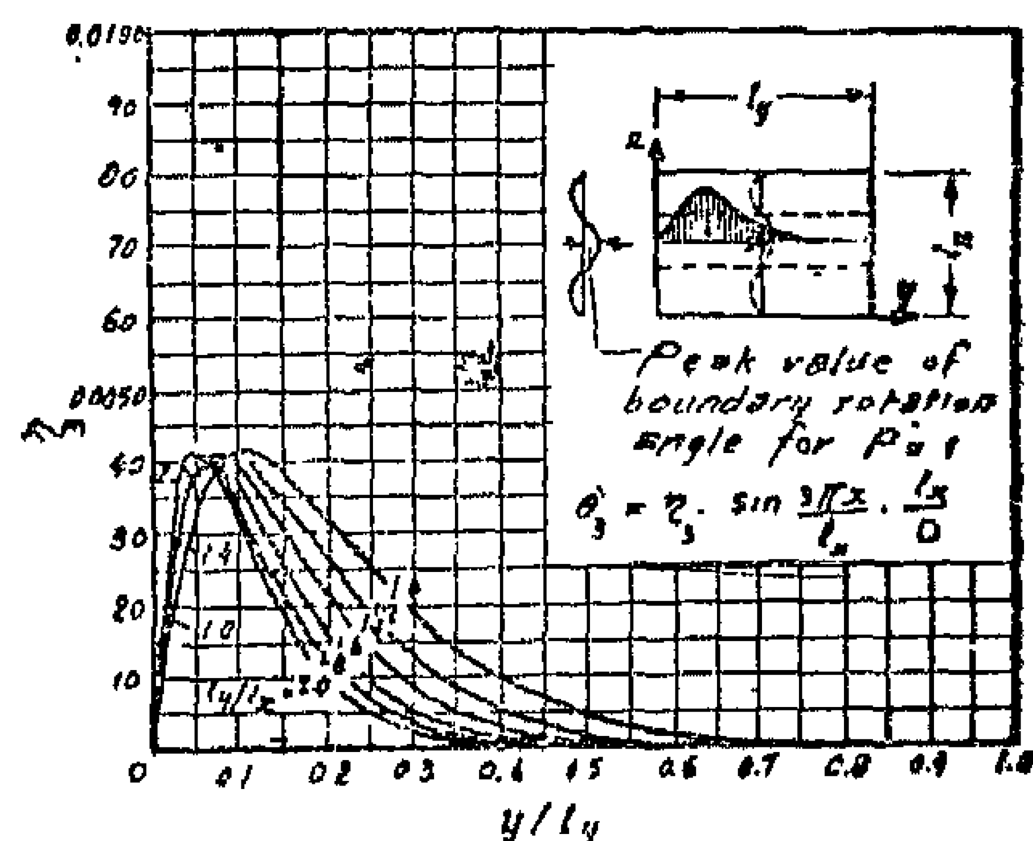
Fig(8)



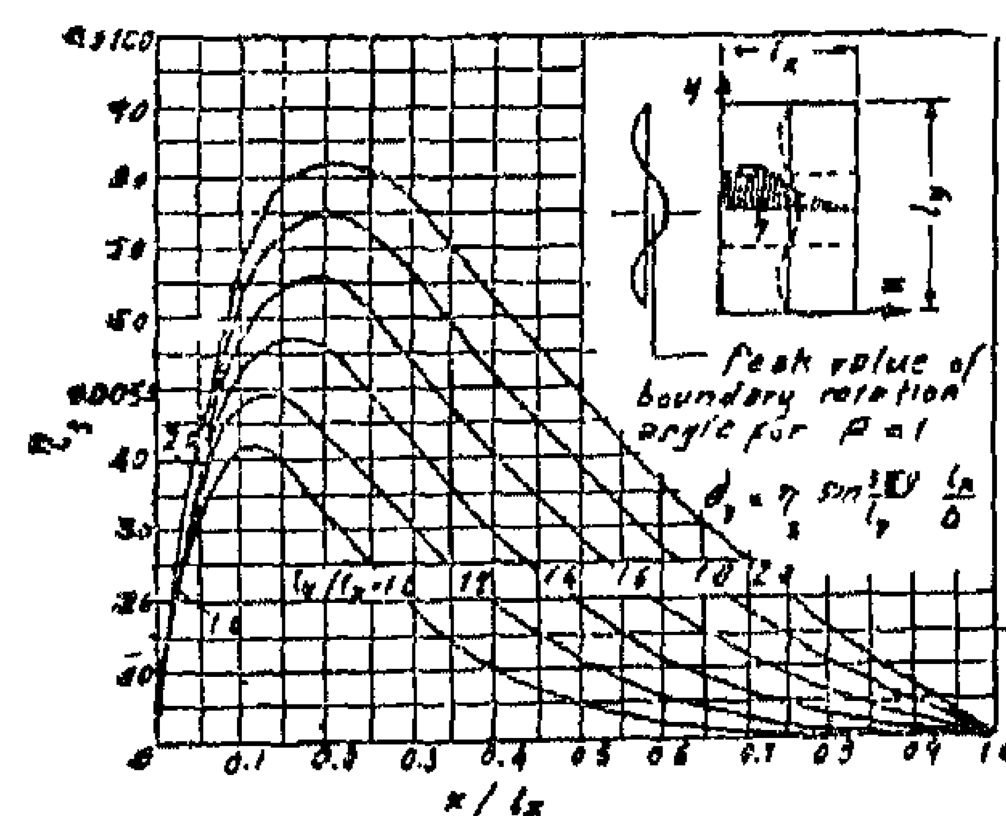
Fig(9)



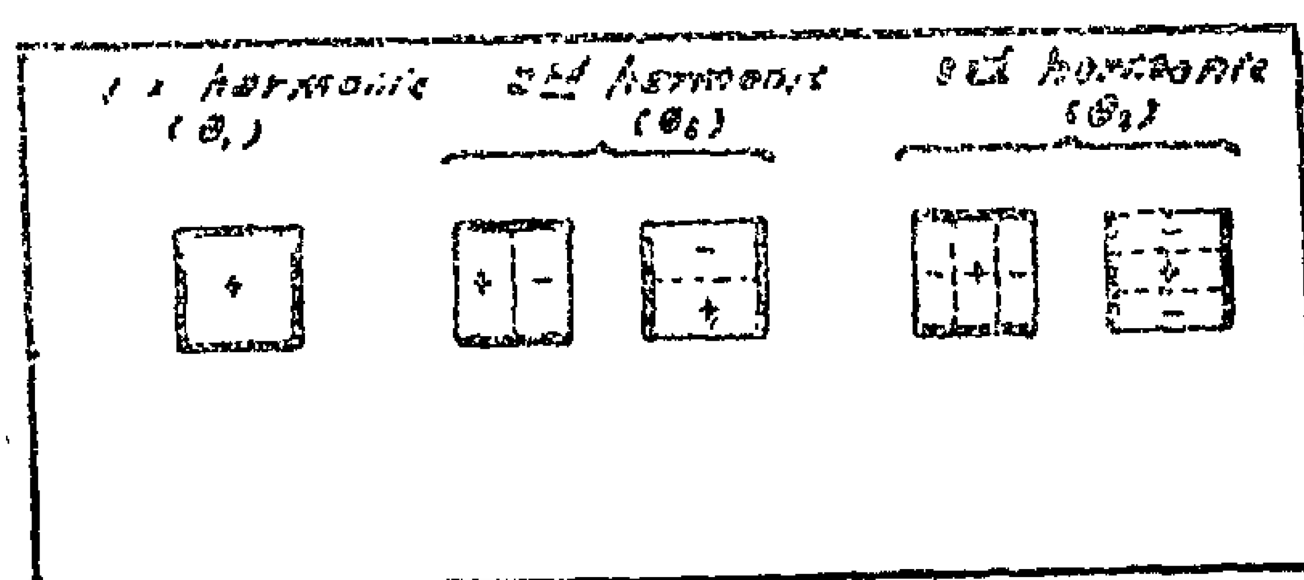
Fig(10)



Fig(11)



Figures(6 to 11) : Curves give the peak values of the angle of rotation of the boundaries due to unit load for simply supported rectangular plates. (For the 1st, 2nd and 3rd harmonics)

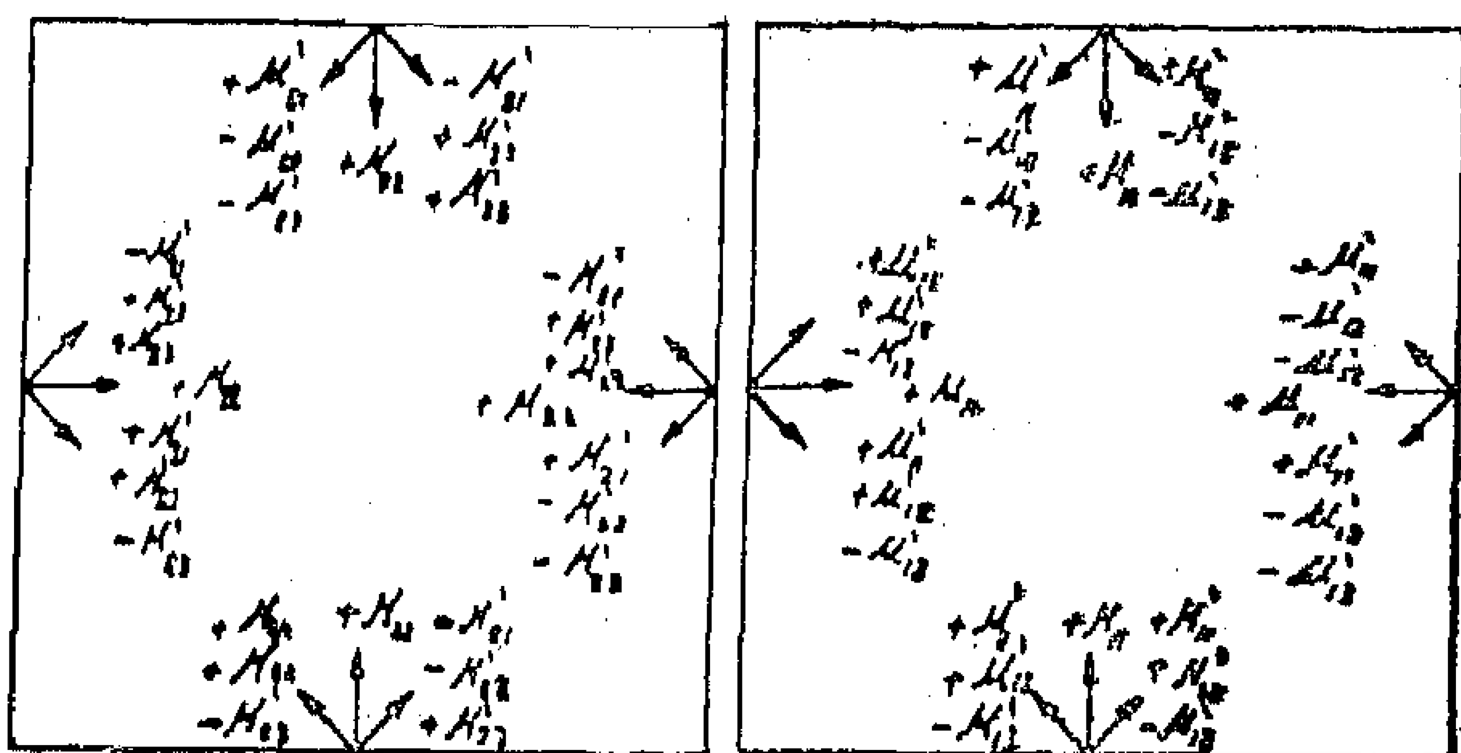


Fig(12) : Sign scheme for the boundary rotation angles.

monics only in case of sufficiently large distance of the concentrated loads from the plate edge. In order to consider the conditions in the region of the reference point, the influence areas of the boundary moments of different plates are calculated with the rotation angle compensation method and compared with the influence areas obtained by Pucher (2). From this comparison a single difference influence area is determined which is denoted by correction influence area, fig. (13). The correction influence area depends only on the length of the considered edge, considering the perpendicular

l_y/l_x	1st Harmonic				2nd Harmonic				3rd Harmonic			
	μ_{1x}	μ_{1y}	$\bar{\mu}_{1x}$	$\bar{\mu}_{1y}$	μ_{2x}	μ_{2y}	$\bar{\mu}_{2x}$	$\bar{\mu}_{2y}$	μ_{3x}	μ_{3y}	$\bar{\mu}_{3x}$	$\bar{\mu}_{3y}$
1.0	0.144	0.056	0.055	0.144	0.068	-0.026	-0.024	[illegible]	0.021	-0.032	-0.032	0.021
1.1	0.140	0.032	0.083	0.144	0.054	-0.023	-0.024	0.081	0.015	-0.030	-0.013	0.030
1.2	0.133	0.015	0.109	0.142	0.043	-0.020	-0.021	0.094	0.010	-0.005	-0.019	0.039
1.3	0.126	0.002	0.136	0.139	0.034	-0.018	-0.017	0.105	0.007	-0.013	-0.022	0.048
1.4	0.118	-0.008	0.161	0.135	0.027	-0.013	[illegible]	0.115	0.005	-0.003	-0.025	0.054
1.5	0.109	-0.015	0.185	0.128	0.021	-0.012	-0.002	0.125	0.003	-0.002	-0.026	0.060
1.6	0.100	-0.019	0.207	0.122	0.016	-0.010	0.008	0.130	0.002	-0.002	-0.026	0.077
1.7	0.091	-0.022	0.228	0.115	0.013	-0.008	0.019	0.135	0.001	-0.001	-0.023	0.086
1.8	0.084	-0.025	0.247	0.109	0.010	-0.006	0.030	0.139	0.001	-0.001	-0.027	0.094
1.9	0.075	-0.025	0.264	0.103	0.008	-0.005	0.043	0.142	0.001	0	-0.028	0.102
2.0	0.068	-0.025	0.280	[illegible]	0.006	-0.004	0.056	0.144	0	0	-0.035	0.109

Table(4) : Moment influence factors due to n-th harmonic of the boundary moment ($\nu = 0$)



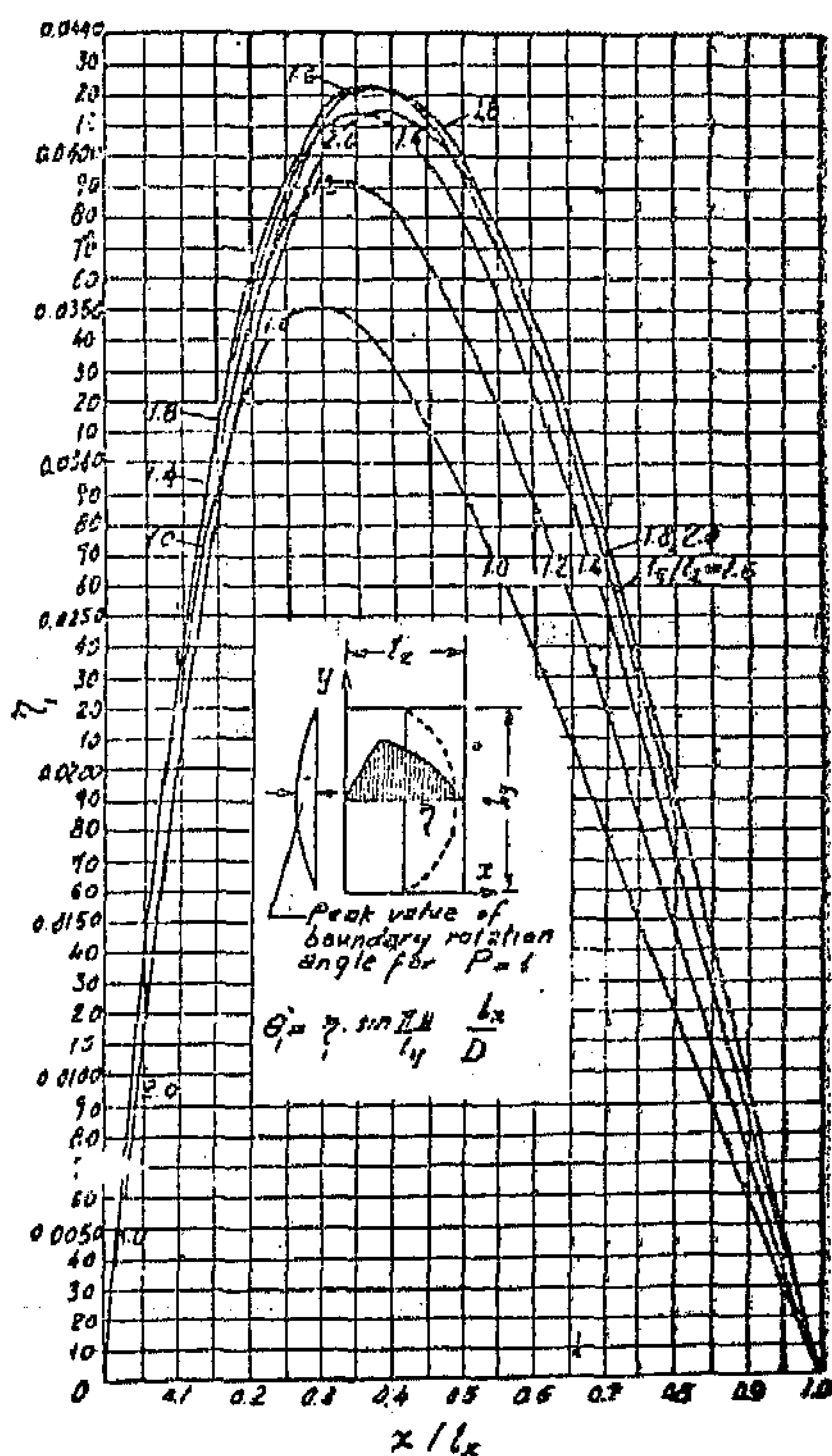
Fig(5) : Sign scheme for the rotation angle carry over factors

of procedures of distribution and carry over.

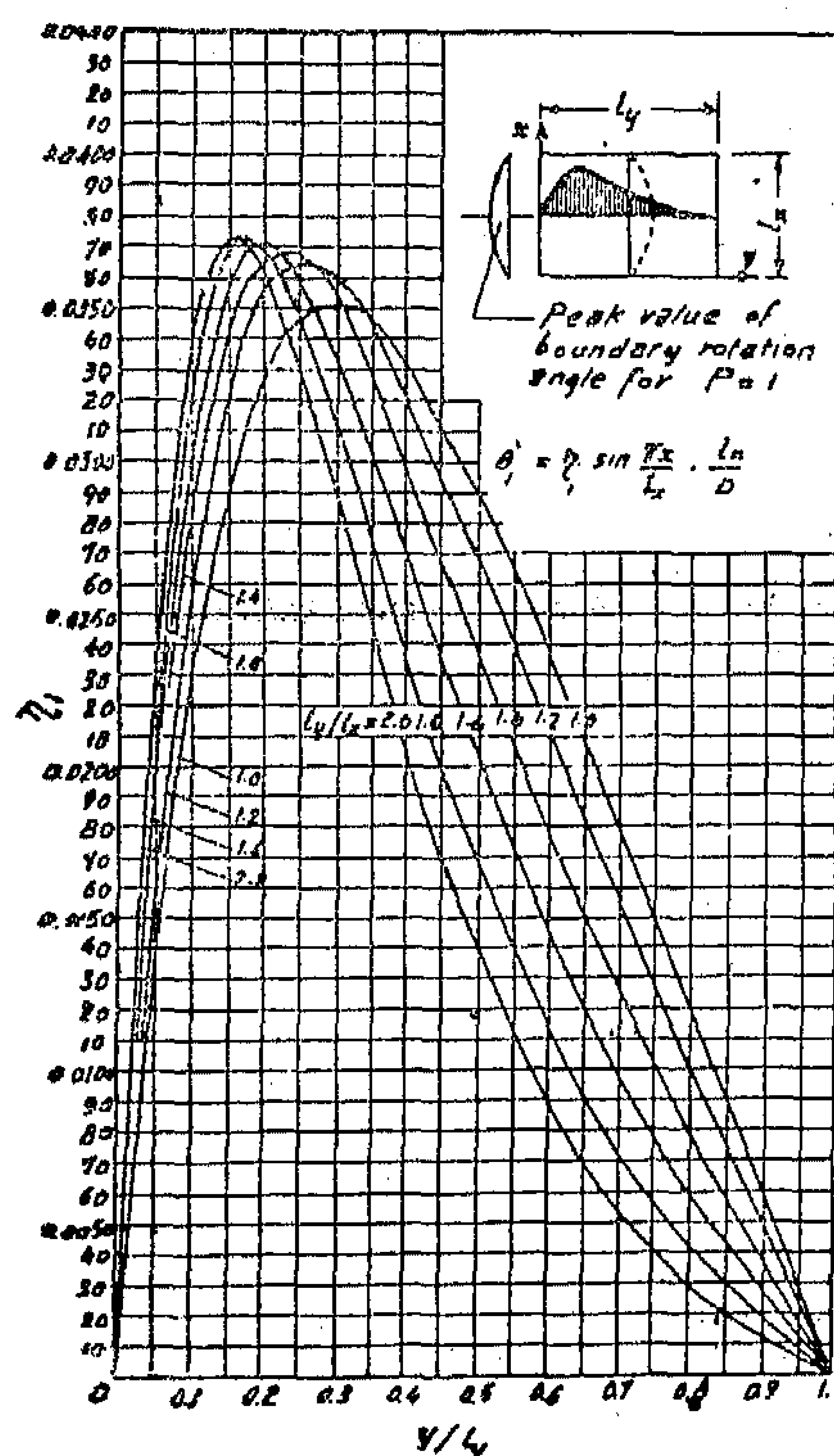
6. Determination of boundary moments from the sum of the restoring rotation angles (ϕ).
7. Calculation of field moments of simply supported plate from the available tables, influence areas, ... ect.
8. Determination of the field moment of the elastically fixed plate by means of influence factors, table (4) and equations 3 & 4.
9. The algebric sum of the moments obtained from steps (7 and 8) gives the final field moment at the rquired point.

4.3) Additional Calculations in the Region of the Reference Point :

The method shown before fails in the vicinity of the reference point, and that is because the boundary rotation angles of a plate can be represented by three sinusoidal har-



Fig(6)



Fig(7)

factors where the influence factors are those numbers with which the boundary moments are to be multiplied to get the field moments of the considered plate points.

The following notation is introduced :

μ_{nx}, μ_{ny} : moment influence factors due to n-th harmonic of the boundary moment at the short side.

$\bar{\mu}_{nx}, \bar{\mu}_{ny}$: moment influence factors due to n-th harmonic of the boundary moment at the long side.

If the boundary moments are applied to all four edges of a plate as shown in

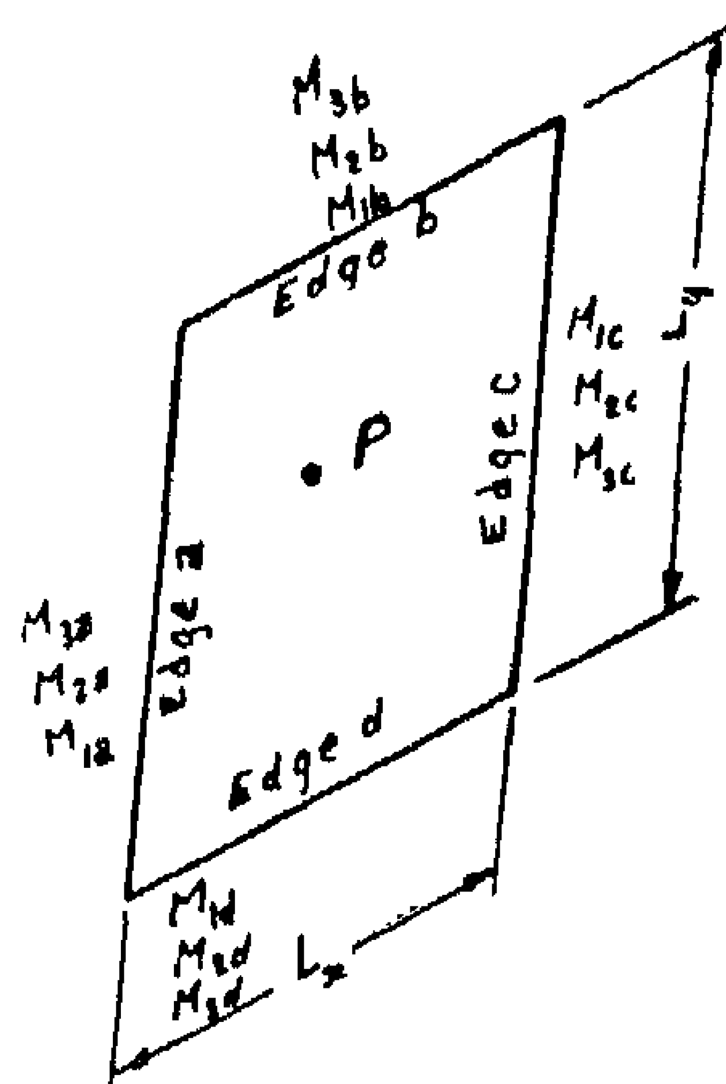


Fig. (4)

fig. (4), then the moment at any point (p) will be :

$$M_x = \Sigma(M_{na} + M_{nc})\bar{\mu}_{nx} + \Sigma(M_{nb} + M_{nd})\mu_{nx} \quad (3)$$

$$M_y = \Sigma(M_{na} + M_{nc})\bar{\mu}_{ny} + \Sigma(M_{nb} + M_{nd})\mu_{ny} \quad (4)$$

Table (4), gives for the middle and quarter points of the plate, the moment influence factors ν = 0) of the first, second and third harmonics. The signs of the influence factors are given in the same table.

4. 2) Calculation Procedure :

The calculation procedure is as follows :

1. Calculation of unit rotation angle ($\propto_n$) and boundary stiffness (K_n), table (1).
2. Evaluation of the distribution factors from the unit rotation angles, equations 1 and 2.
3. Determination of the rotation angle carry over factors (tables 2,3), as well as, fixing their signs fig. (5).
4. Calculation of boundary rotation angles of the simply supported plate due to applied loads (Fig. 6 to 11) and fixing their signs fig. (12).
5. Rotation angle compensation in form

l_y/l_x	Opposite side	Adjacent side			Opposite side	Adjacent side		
	μ_{11}	μ'_{11}	μ'_{12}	μ'_{13}	μ_{11}	μ'_{11}	μ'_{12}	μ'_{13}
1.0	0.194	0.318	0.087	0.025	0.190	0.318	0.087	0.023
1.1	0.158	0.312	0.095	0.029	0.223	0.320	0.078	0.023
1.2	0.128	0.301	0.103	0.032	0.253	0.318	0.072	0.020
1.3	0.104	0.289	0.108	0.036	0.279	0.313	0.065	0.018
1.4	0.084	0.274	0.113	0.039	0.302	0.306	0.060	0.016
1.5	0.067	0.259	0.115	0.042	0.322	0.298	0.055	0.014
1.6	0.053	0.243	0.117	0.044	0.339	0.290	0.051	0.013
1.7	0.041	0.228	0.118	0.046	0.355	0.281	0.047	0.012
1.8	0.033	0.213	0.117	0.047	0.368	0.272	0.044	0.011
1.9	0.025	0.198	0.115	0.048	0.384	0.263	0.041	0.010
2.0	0.020	0.184	0.113	0.049	0.390	0.255	0.039	0.010

l_y/l_x	Opposite side	Adjacent side			Opposite side	Adjacent side		
	μ_{22}	μ'_{21}	μ'_{22}	μ'_{23}	μ_{22}	μ'_{21}	μ'_{22}	μ'_{23}
1.0	0.020	0.184	0.113	0.049	0.020	0.184	0.113	0.049
1.1	0.012	0.159	0.107	0.050	0.032	0.210	0.117	0.048
1.2	0.007	0.136	0.099	0.050	0.045	0.233	0.118	0.045
1.3	0.004	0.117	0.089	0.048	0.061	0.253	0.116	0.042
1.4	0.003	0.099	0.081	0.045	0.079	0.270	0.113	0.040
1.5	0.002	0.085	0.072	0.043	0.097	0.283	0.110	0.036
1.6	0.001	0.073	0.062	0.040	0.116	0.295	0.105	0.034
1.7	~0	0.062	0.055	0.036	0.135	0.304	0.101	0.031
1.6	~0	0.052	0.048	0.033	0.154	0.311	0.096	0.029
1.9	~0	0.044	0.041	0.029	0.172	0.315	0.092	0.027
2.0	~0	0.038	0.036	0.026	0.190	0.318	0.087	0.025

Tables (2 , 3) : Rotation-angles carry over factors for the first and second harmonics.

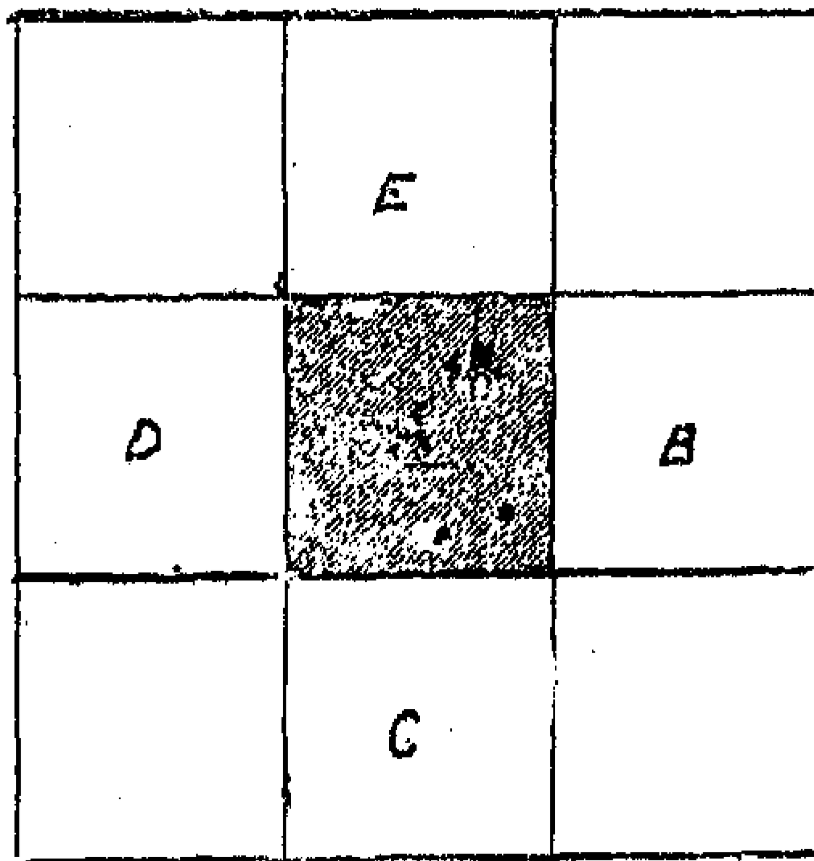


Fig. 1.

The method is analogous to Cross-moment distribution method for the analysis of continuous beams and frames. The main advantage of the method is that the calculations can be stopped at any early stage as required, this leads in many cases to sparing much time without any considerable loss in accuracy.

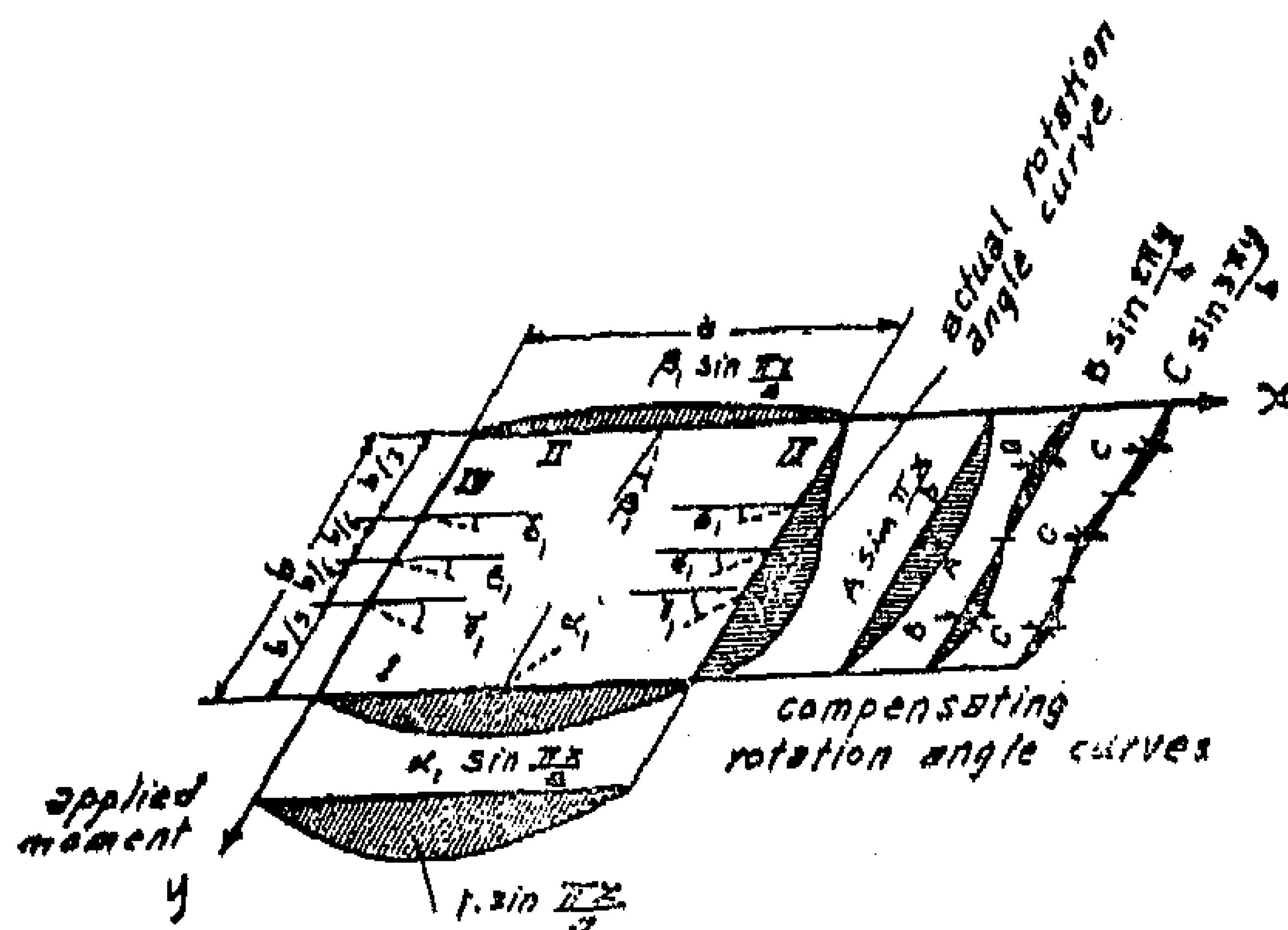


Fig. 2.

Considring a plate (A) loaded as shown in fig. (1) by a concentrated load P. If the plate is to be simply supported, all the surrounding edges 1, 2, 3 and 4 are liable to rotate. The actual boundary rotation angle curves are represented by the sinusoidal curves from the first, second, and third harmonics as shown in fig. (2). For example, in order to satisfy the continuity conditions at edge (1), three restoring rotation angle curves $\phi_{nc} \sin \frac{\pi x}{a}$ and $\phi_{nr} \sin \frac{n \pi x}{a}$ are introduced to the left and right of edge (1), which successively re-establish the continuity for the first harmonic by means of two restoring rotation angle curves $\phi_{1c_l, r} \sin \frac{\pi x}{a}$, and similarly for the second and third harmonics. Because of the restoring rotation angle curves, the remaining edges 2, 3 and 4 will be extra rotated (or twisted). The additional rotation can be divided into 3-sinusoidal curves which will be added to the rotation angle curves already obtained at these three edges. Similarly like edge (1), all edges will be balanced one by one until we reach the required accuracy. For example, the compensation of the first harmonic can be seen in fig. (3). The condition of continuity is :

$$\phi_{I_L} + \theta_{I_L} = -(\phi_{I_r} + \theta_{I_r})$$

$\Theta_{I_L}, \Theta_{I_L}$ = are the peak values of the edge rotation angle curves (1st harmonic) due to applied loads for simply supported plate.

ϕ_{I_r}, ϕ_{I_r} = are the peak values of the compensating rotation angle curves.

Hence we find :

$$\phi_{1r} = -(\theta_{1r} + \theta_{1r}) \cdot \frac{\alpha_{IL}}{\alpha_{I_L} + \alpha_{I_r}} \qquad (1)$$

$$\phi_{1r} = -(\theta'_{I_r} + \theta_{ic}) \cdot \frac{\alpha_{1r}}{\alpha_{1L} + \alpha_{1r}} \qquad (2)$$

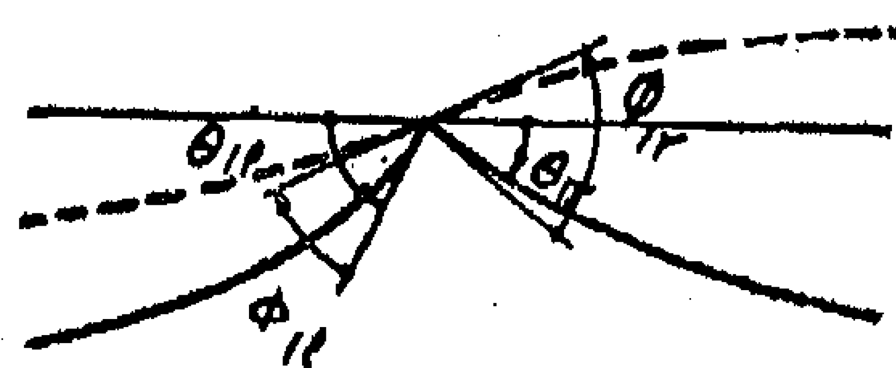


Fig. 3.

The effect of the individual boundary moments is obtained by means of influence

ding the concentrated loads, the new theories of the influence surfaces have proved to be convenient for calculating the absolute maximum bending moments for isolated panels. As regards continuous slabs which are more frequent in practice, no influence surfaces have been developed in a practical form for designers. The problem of the analysis of continuous plates was treated by some research workers among them were C.Siess & N.M.Newmark(4) and W. Brunner(3)... In the method derived by Brunner, the actual rotation angle curves of the plate boundaries are represented by three sinusoidal curves from the first, second and third harmonics. The peak values of edge rotation angles which are considered as unit rotations and their

reciprocals as boundary rigidities, are given is table (1) for different side ratios. The rotation angles of the edges due to applied loads can be distributed for the first, second and third harmonics as in the Cross-method, but with replacing the boundary stiffness by the unit rotation angles, to the right and to the left of the boundary is to be multiplied by the corresponding boundary stiffness to obtain the required boundary moment. To simplify the practical application of that method, a group of curves is established for determining the boundary rotation angles of the first, second and third harmonics due to the applied loads. Obtaining the boundary moments, the field moments could be computed by means of influence factors given in table (4). In the vicinity of the reference point, additional moments are to be considered and these moments are given by a correction influence area (Fig. 13).

The main objective of this investigation is to introduce influence surface charts for bending moments in continuous rectangular slabs at the most critical points for various edge conditions showing the effect of loading the adjacent panels on the required moment in the studied panel.

4) The Angle of Rotation Balancing Method for the Analysis of Continuous Plates subjected to any loading

4.1) General Description of the Method:

This method is based on the principal that the problem of continuous plates is considered as a statically indeterminate problem, and the continuity conditions at the plate boundaries are reestablished by means of boundary moments.

Table(1) : Unit rotation angles and boundary stiffnesses for simply supported rectangular plates in case of sinusoidal applied boundary moments. (1st, 2nd & 3rd harmonics)

l_y/l_x	Applied moments: $1 \sin \frac{\pi x}{l_x}$, $1 \sin \frac{2\pi x}{l_x}$, $1 \sin \frac{3\pi x}{l_x}$ — Boundary rotation angle curves: $\alpha_1 \sin \frac{\pi x}{l_x}$, $\alpha_2 \sin \frac{2\pi x}{l_x}$, $\alpha_3 \sin \frac{3\pi x}{l_x}$						Applied moments: $1 \sin \frac{\pi y}{l_y}$, $1 \sin \frac{2\pi y}{l_y}$, $1 \sin \frac{3\pi y}{l_y}$ — Boundary rotation angle curves: $\alpha_1 \sin \frac{\pi y}{l_y}$, $\alpha_2 \sin \frac{2\pi y}{l_y}$, $\alpha_3 \sin \frac{3\pi y}{l_y}$					
	α_1	α_2	α_3	K_1	K_2	K_3	α_1	α_2	α_3	K_1	K_2	K_3
1.0	0.1560	0.0796	0.0531	6.41	12.57	18.83	0.1560	0.0796	0.0531	6.41	12.57	18.83
1.1	0.1572	0.0796	0.0531	6.36	12.57	18.83	0.1696	0.0875	0.0584	5.90	11.43	17.12
1.2	0.1581	0.0796	0.0531	6.33	12.57	18.83	0.1823	0.0955	0.0637	5.49	10.47	15.70
1.3	0.1585	0.0796	0.0531	6.31	12.57	18.83	0.1841	0.1033	0.0690	5.15	9.68	14.49
1.4	0.1588	0.0796	0.0531	6.30	12.57	18.83	0.2048	0.1112	0.0743	4.88	8.89	13.46
1.5	0.1590	0.0796	0.0531	6.29	12.57	18.83	0.2148	0.1189	0.0796	4.66	8.41	12.56
1.6	0.1590	0.0796	0.0531	6.29	12.57	18.83	0.2239	0.1267	0.0849	4.47	7.89	11.78
1.7	0.1591	0.0796	0.0531	6.20	12.57	18.83	0.2321	0.1342	0.0902	4.31	7.45	11.09
1.8	0.1591	0.0796	0.0531	6.29	12.57	18.83	0.2396	0.1417	0.0954	4.17	7.06	10.48
1.9	0.1591	0.0796	0.0531	6.29	12.59	18.83	0.2464	0.1490	0.1007	4.06	6.71	9.93
2.0	0.1591	0.0796	0.0531	6.29	12.57	18.83	0.2526	0.1560	0.1060	3.96	6.41	9.43
	$\cdot l_x/D$	$\cdot l_x/D$	$\cdot l_x/D$	$\cdot D/l_x$	D/l_x	$\cdot D/l_x$	$\cdot l_x/D$	l_x/D	$\cdot l_x/D$	D/l_x	$\cdot D/l_x$	D/l_x
	$K_n = 1/\alpha_n$ $D = Eh^3/12(1-\nu^2)$ l_x is the shorter side											

DEVELOPMENT OF INFLUENCE SURFACES FOR CONTINUOUS PLATES AND DESIGN APPLICATION

BY

ABDEL-HADY H. HOSNY*, M. SC.,PH.D,

OSAMA A. B. EL-SHAFEY,, M. SC.**

1) SYNOPSIS

The main objective of this paper is to provide the designers with a convenient solution for the problem of continuous plates with different edge conditions and subjected to concentrated loads. This is done by the development of a group of influence surface charts for bending moments at the most critical points for continuous plates with different edge condifions. The influence coefficients are obtained using Brunner's method for solving continuous plates subjected to concentrated loads. It is assumed that all the supporting beams are nondeflecting and offer no restraint against rotation of the slab. A general computer programme (Fortran IV) is developed for solving continuous plates subjected to concentrated loads. The programme has general validity to be used for rectangular plates with different edge conditions and different side ratios. It also gives the inflence coefficients for the effect of loading the adjacent panels on the value of the required moment at the studied point. As an application on the use of the developed influence surface charts, a group of curves relating bending moments at the most critical points and the side length of a continuous square plates subjected to loads according to the Egyptian Code of Practice for roadway bridges, is developed.

2) Notations

P : Single concentrated load

α_n : Unit rotation angle

K_n : Boundary rigidity

ϕ : Restoring rotation angle

Θ^n : Peak value of rotation angle curves due to applied loads for simply supported edges

ν : Poisson's ratio

E : Modulus of elasticity

D : Flexural rigidity of a plate

μ μ' : Carry over factors for opposite and adjacent sides respectively

M_x, M_y : Bending moments per unit length of sections of a plate in direction of x-axis and y-axis respectively

3) Introduction

The exact analysis of continuous plates is complicated due to the combination of uniformly distributed loads and concentrated loads, as well as, the different boundary conditions. Regar-

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BUILDING & CONSTRUCTION

INSTITUTION OF CIVIL ENGINEERS
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المحاريث والهندسة .. ومجمع الحديد والصلب

قامت الشركة بأعمال التركيبات الميكانيكية والكهربائية بمناطق التلبيد والأفران والورش والصلب

راس الدكتور محمود فوزى نائب رئيس الجمهورية نيابة عن الرئيس محمد انور السادات الاحتفال باستقبال اول صبة جديدة من انتاج الفرن العالى الثالث لمجمع الحديد والصلب بعد اشعاله وببدء انتاج الفرن العالى الثالث البالغ حوالى ٢٠٠٠ طن يوميا .. يرتفع انتاج مصر من الصلب من ٣٠٠ الف طن سنويا الى مليون طن .

ويلتقى الدكتور محمود فوزى بالطاقات الوطنيـة التى شاركت فى بناء هذا الصرح الصناعى الشامخ قاعدة انطـلاق الصناعة الثقيلة فى مصر .. ومن بين هذه الطاقات الوطنية نلقى الضوء على شركة المحاريث والهندسة احدى شركات مؤسسة التجارة التى ساهمت بجهد بارز خلاق فى أعمـال التركيبات الميكانيكية والكهربائية فقد قامت المحاريث والهندسة بتركيب ١٣٠٠٠ طن معدات ميكانيكية وكهربائية ومواسير وكذلك ١٦٠٠٠ متر مربع صاج لزوم أعمال التهوية لانهاء أعمال التركيبات بالمرحلة الاولى لتشغيل الفرن العالى الثالث بمناطق :

التلبيد ـ الافران ـ الورش والمرافق المساعدة ـ الصلب .

وتشمل هذه الاعمال تركيب جميع المعدات الميكانيكيـة والكهربائية والمواسير واعمال التهوية بمنطقة التلبيد .

الاعمال الميكانيكية :

قامت المحاريث والهندسة بتركيب ٩٥٠ طن معـدات ميكانيكية بمناطق التلبيد والصلب والافران والورش وتشـمل تركيب ماكينتى التلبيد الرئيسيتين بوزن ١٨٠٠ طن وماكينتى تبريد الملبد بوزن ١٥٠٠ طن وكذلك تركيب ماكينـة تجنيس الخام بوزن ٢٦٠ طنا ، كما قامت الشركة بتركيب السيور الناقلة للخامات من الحديد وفحم وحجر جيرى بطول ١٨ كيلو مترا ، بالاضافة الى تركيب كسارات لزوم الخام والفحم والحجـر الجيرى ، ١١ كسارة ، وكذلك ٧ خلاطات لخلط الخام وقد قامت الشركة بتركيب ٣٠ محطة طلمبات ـ مياه نزح ـ منها محطة الطلمبات الرئيسية رقم (١) بمنطقة الافران وقدرتها ١٠ آلاف متر مكعب فى الساعة وهى المحطة التى تغذى الفرن العالى الثالث بالمياه .

منقيات الهواء :

ولقـد أسند الجهاز التنفيذى لمجمع الحديد والصلب عملية تصنيع وتركيب منقيات الهواء للشركة وهى التى تقوم بتنقيـة الهواء بمنطقة التلبيد ، كما تم تركيب مواسير الشحن والزيت الخاصة بماكينتى التلبيد وتبريد الملبد ٩٠٠٠ متر مواسـير أقطار مختلفة .

المواسـير :

قامت المحاريث والهندسة بتركيب ١٤٠٠ طن مواسير اقطار مختلفة لزوم اعمال المياه والمجارى والبخار والشحم والمازوت بمناطق التلبيد والافران والصلب والورش اللازمة للمعدات الميكانيكية بخـلاف تركيب المرشحات والرشاشات والبلوف اللازمة لها .

اعمال التهوية :

قامت الشركة بتصنيع وتركيب ٢٦٠٠٠ متر مربع مجارى هواء صاج ١ مم ، ٢ مم ، ٣ مم بوزن اجمالى ٤٣٦ طنا وذلك بخلاف المشغولات الغير قياسية اللازمة للتركيب وكذلك قامت الشركة بتركيب عدد ٢٦ منقى هواء يزن الواحد فى المتوسط ٧ طن .

تصنيع وتركيب المعدات ـ الاعمال الغير قياسية .

أسند الجهاز التنفيذى لمجمع الحديد والصلب الى الشركة بتصنيع وتركيب ٣٥٠ طنا مشغولات من الحديد والزهر وكاوتش والاخشاب لزوم السيور الناقلة .

ورشة مركزية للصيانة :

وقد قامت شركة المحاريث والهندسة ببناء ورشة مركزية لخدمة مواقع العمل لتصنيع احتياجات مواقع العمل مجهزة بجميع أنواع الماكينات اللازمة لهذه العملية من مخارط ومثاقب ومقصات وماكينات لقلوظة المواسير ودرافيل وثنايات لزوم أعمال التهوية .

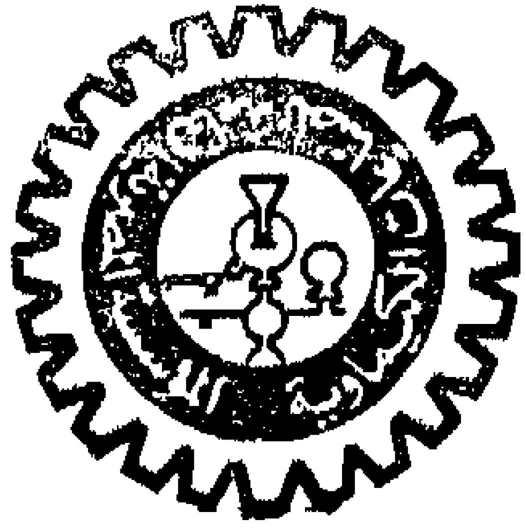
الاعمال الكهربائية :

قامت الشركة بتركيب ١١ محطة محولات بمناطق التلبيد والصلب والافران وكذلك محطة التحكم المركزى لتشغيل منطقة التلبيد .

وتشمل الاعمال الكهربائية بمنطقة التلبيد والتى نفذتهـا المحاريث والهندسة .

* ٥٩ خلية كهربائية ضغط عالى ٦٫٣ ك.ف. أ .
* ٢٢ محولات كهربائية تتراوح قدرتها من ٧٥٠ الى ١٦٠٠ ك.ف.أ .
* ٧٥٣ لوحة توزيع وتحكم وتشغيل كهربائية .
* ١٦٠٠ لوحة تشغيل كاملة بالمفاتيح والمقومات الكهربائية .
* ٧٥٠٠٠ متر وصلة كهربائية .
* ١٠٠ الف متر مواسير كهرباء أقطار مختلفة .
* ٦٠ الف متر اسلاك كهربائية .
* ٣٠٠ الف متر كابلات كهربائية مقاسات مختلفة .
* ١١ الف متر كابلات لزوم اعمال التليفونات .
* ٧٠٠٠ متر مواسير لزوم أعمال التليفونات .
* ٤٠ الف متر كابلات كهربائية لزوم الاجهزة الدقيقة .
* ٤٠ ألف متر مواسير لزوم الاجهزة الدقيقة .
* ٢٥ ألف متر شبكة ارضية من الخوص الحديدية داخل وخارج المبانى .
* ٣٠٠ بئر تفريغ للشحن الكهربائية وبعد .. لقد ساهمت المحاريث والهندسة بجهد بارز فى هذا العمل العظيم ورفرفت راياتها فوق العديد من الاعمال البارزة بالشروع .. وحق العاملين فيها بقيادتهم أن توجه لهم كلمة شكر وتقـدير .. فمجمع الحديد والصلب ، السد العالى الثانى ، كما قال الرئيس محمد انور السادات هو أمل مصر فى تدعيم اقتصادنا القومى وهو القاعدة لانطلاق الصناعات الثقيلة .

دور المؤسسة المصرية العامة للصناعات الكيماوية في خدمة الإنتاج



تعتبر الصناعات الكيماوية الدعامة الأولى لكافة مجالات النشاط حيث تستخدم منتجاتها فى جميع قطاعات الانتاج والاستهلاك سواء كمواد أولية لبعض الصناعات أو مواد وسيطة للبعض الآخر أو كيماويات نهائية ففى المجال الزراعى تقدم منتجات الصناعات الكيماوية الأسمدة والمبيدات الزراعية وفى المجال الاعلامى تقوم الصناعات الكيماويةبسد الاحتياجات من الورق وأحبار الطباعة والكتابةوفى مجال الانشاءات يتم امداد المنشآت بالبويات والاخشاب الصناعية ومواسير المياه والكهرباء وقار الطرق والمواد العازلة كما تنتج الصناعة الكيماوية الاطارات والبطاريات السائلة لخدمة قطاع النقل.

وتدخل الصناعات الكيماوية فى حياتنا العامة واليوميةفى شتى المجالات الأخرى سواء من المنتجات المنزلية كادوات المائدة من البلاستيك أو الثقاب او الأقلام الرصاص ولعب الأطفال وغيرها .

وتشرف المؤسسة المصرية العامة للصناعات الكيماوية على ٢٩ شركة تضم ٧٠ مصنعا من أكبر المصانع العاملة فى مختلف مجالات الصناعات الكيماوية فى جمهورية مصر العربية ويمكن تقسيم هذه المجالات الى النواحى الرئيسية التالية :

١ ـ قطاع الاسمدة :

ويشمل أربعة شركات كبرى يمثل انتاجها نسبة كبيرة من اجمالى انتاج المؤسسة وهى شركة الصناعات الكيماوية المصرية (كيما) وشركة النصر للاسمدة والصناعات الكيماوية وشركة أبو زعبل للاسمدةوالمواد الكيماويةوالشركة المالية والصناعية المصرية بالاضافة الى مصنع السماد الازوتى لشركة النصر لصناعة الكوك والكيماويات الاساسية وتقوم هذه الشركات بانتاج السماد الازوتى (نترات النوشادر الجيرى) ٣١ ، ٣٣ ٪ وسماد سوبر فوسفات الجير ١٥ ٪ وسماد سلفات النوشادر ٢٠٫٥ ٪ ويغطى الجزء الأكبر من احتياجات القطاع الزراعى من هذه الاسمدة وبالاضافة الى السماد الأزوتى والفوسفاتى تنتج شركات هذا القطاع عدد كبير من المواد الكيماوية الأساسية ومنها حامض الكبريتيك المستخدم فى صناعة البطاريات السائلة وصناعة المفرقعات والمواد الكيماوية المختلفة والنوشادر المستخدم فى صناعة التبريد والفرسيلكون المستخدم فى صناعة الحديد والصلب وتبلغ قيمة انتاج هذا القطاع حوالى ١٤٫٥ مليون جنيها سنويا كما يبلغ عدد العاملين فيه ٩٧٢٠ عاملا .

٢ ـ قطاع صناعة الورق ومنتجاته :

ويضم شركات العامة لصناعة الورق (ركتا) والورق الأهليـة والورق للشرق الأوسط سيمو ومطابع محرم الصناعية وتصنيع الورق (فرتا) ويقوم هذا القطاع بانتاج مختلف أنواع ورق الكتابة والطباعة وكذا أنواع الورق والكرتون المستخدم فى مختلف الأغراض الصناعيـة وفى عمليات التعبئة والتغليف والتى تشمل ورق الزبدة وورق السلفيت والبوستر والكرافت وكرافت التغطية وورق الشرنز والمانيلا وورق الغـلاف وورق الطبقة الوسطى والكرتون الأبيض والرمادى والمتعدد الطبقات ويتم انتاج نسبة كبيرة من اللب المستخدم فى انتاج الورق من المخلفات الزراعية المحلية مثـل قش الأرز والبوص . وتقوم شركات هذا القطاع بانتاج مختلف أنواع العبوات مثل علب وصناديق الكرتون العادى والمضلع وورق تغليف الحلوى والمطبوعات التجارية على اختلافها وتقدر قيمة انتاج هذا القطاع سنويا بمبلغ ٢٩٫١٤ مليون جنيه ويبلغ عدد العاملين به ١١٤٥٠ عاملا .

٣ ـ قطاع صناعة الكيماويات الاساسية :

ويضم هـذا القطاع شركات النصر للكوك والكيماويات الأساسية ومصر لصناعة الكيماويات ومواد الصباغة والكيماويات وتقوم بانتاج عدد كبير من المواد الكيماوية والوسيطة اللازمـة لمختلف الصناعات والقطاعات ومن أهم هذه المنتجات فحم الكوك اللازم لصناعة الحديد والصلب ولعمليات السباكة وكذا الغازات اللازمـة لصناعة السماد الآزوتى الى جانب منتجـات البنزين والتولوين والزيلين المستخدمة فى صناعة البويات والمبيدات وفى الصناعات الحربية والقار المستخدم فى رصف الطرق وفى عزل الأخشاب والمواسير والمبانى كمـا تنتج شركة القطاع مادة الصودا الكاوية المستخدمة فى صناعة الورق والزيوت والصـابون والمنظفات الصناعيـة وفى تجهيز المنسوجات وتحريرها وفى صناعة الحرير الصناعى والكيماويات الدوائيـة وتكرير البترول وغيرها من الصناعات وكذا مادة الكلور المستخدمة فى تنقية المياه وتبييض المنسوجات وفى صناعة اللب والمبيدات الحشرية وفى صناعـة الأحماض وغيرها كما بدأت شركات هذا القطاع فى انتاج مواد الصباغة والمواد الوسيطة اللازمة لقطاع الغزل والنسيج ومنهـا مادة هيـدروسلفيت الصـوديوم والصبغات المباشرة بأنواعها وصبغات

الأحواض وقد بلغت قيمة الانتاج السنوى لهذا القطاع حوالى ١٧ر٧٠٠ مليون جنيه كما بلغ عدد العاملين به ٥٩٦٠ عاملا .

٤ ـ قطاع صناعة الاخشاب ومنتجاتها :

ويضم هذا القطاع ٤ شركات هى شركة النصر للخشب المضغوط بفارسكور وشركة النصر لصناعه الخشب الحبيبى والراتنجات والشركه المصرية لصناعه الأخشاب وشركة طنطا للكتان والزيوت وكذا مصنع منتجات الاخشاب بشركة النيل للكبريت ويخدم انتاج هذا القطاع نشاط الاسكان وصناعة الاثاث والمنتجات الخشبيه بالاضافة الى ما يتم من انتاج الأثاثات الخشبية والكراسى واخشاب الباتوه فان هذا القطاع يقوم بانتاج الخشب الحبيبى والمضغوط من المخلفات الزراعيه المحلية مثل ساس الكتان وقش الارز لسد نسبة من احتياجات البلاد من الاخشاب الطبيعية المستورده . كما يقوم بامداد مصانع المنتجات الخشبية بانتاجه من الابلاكاج والقشره وكذا تقوم شركات هذا القطاع بانتاج كميه من ألياف الكتان والدوبارة وزيت بذر الكتان .

٥ ـ قطاع صناعة منتجات الكاوتشوك :

ويضم هذا القطاع شركتى النقل والهندسة والنصر لصناعة منتجات الكاوتشوك ومن انتاج هذه الشركات الاطارات الخارجية والداخلية لسيارات الركوب والنقل والجرارات الزراعية والمقطورات والدرجات والموتوسيكلات بالاضافة الى منتجات الكاوتشوك من السيور والخراطيم والقطع الفنية المكبوسة ومنتجات اللاتكس ولعب الاطفال وأرضيات وبلاط ـ الكاوتشوك بالاضافة الى الخدمات التى تقوم بها للشركات الصناعية لتبطين المعدات لاكسابها خاصية مقاومة الاحماض والقلويات .

وتبلغ قيمة الانتاج السنوى لهذا القطاع ١١ر٩ مليون جنيه وعدد العاملين به ٤٦١٠ عاملا .

٦ ـ قطاع صناعة ودباغة الجلود :

وويضم هذا القطاع شركتى المدابغ النموذجية والنصر لدباغة الجلود وتقوم الشركتان بدباغة الجلود المحلية والمستوردة لانتاج كافة أنواع الجلود والمستخدمة فى مختلف الأغراض فمنها الجلود الخفيفة المستخدمة فى صناعة الملابس الجلدية ومنها جلود الوجه لصناعة الأحذية وجلود النعل المستخدمة أساسا فى صناعة الأحذية وصناعة السيور وغيرها وتقوم الشركتان بامداد مصانع منتجات الجلود المختلفة بالجلود المدبوغة ذات المستوى العالى الى جانب قيامها بصناعة بعض المنتجات الجلدية .

وتبلغ القيمة السنوية لانتاج هذا القطاع ٦ر٩ مليون جنيه وعدد العاملين به ٢٥٤٠ عاملا .

٧ ـ قطاع صناعة البلاستيك واللدائن :

ويضم شركتى البلاستيك الأهلية وصناعات البلاستيك والكهرباء المصرية وبالاضافة الى الانتاج العادى للشركتين من المنتجات المختلفة للاستعمالات الصناعية والمنزلية فقد قامتا بتطوير انتاجهما ودخلت فى مجالات جديدة منها منتجات عزل الصوت والحرارة وصناعة مواسير المياه والمجارى والكهرباء ومنتجات تغطية الأرضيات وكسوة الحوائط وقطع الغيار اللازمة للثلاجات والغسالات الكهربائية وأجهزة الراديو والتليفزيون ومنتجات التعبئة والتغليف والأكياس المنسوجة والعادية لتعبئة الأسمدة والمحاصيل الزراعية الى جانب انتاج الشركتين من البطاريات السائلة المختلفة المستخدمة فى السيارات والتليفونات والسكة الحديد وغيرها وتبلغ قيمة الانتاج السنوى لهذا القطاع ٦ر٧ مليون جنيه وعدد العاملين به ٣٥٥٠ عاملا .

٨ ـ قطاع صناعة الكيماويات المتنوعة :

ويضم هذا القطاع شركات الغازات الصناعية وكفر الزيات للمبيدات والكيماويات والبويات والصناعات الكيماوية والنصر لصناعة الاقلام ومنتجات الجرافيت والنيل للكبريت ويقوم هذا القطاع بانتاج عديد من المنتجات التى تخدم القطاعات المختلفة سواء بالنسبة للصناعة والاسكان والصحة والتعليم والاعلام والزراعية ومن انتاجه البويات والورنيشات للاغراض الصناعية والمنزلية واحبار الطباعة للكتب والمجلات والجرائد والغازات المختلفة للاغراض الصناعية والطبية مثل الاوكسجين واكسيد النيتروز واقلام الرصاص وورق الكربون وفرش المحركات الكهربائية (أقطاب البطاريات والمبيدات للاغراض الزراعية والمنزلية وكذا ثقاب الامان وبعض المنتجات الاخرى .

وتبلغ قيمة الانتاج السنوى لهذا القطاع ١٢ر٥ مليون جنيه وعدد العاملين به ٦١٠٥ عاملا .

٩ ـ قطاع التعدين :

ويضم هذا القطاع شركتى النصر للفوسفات وفوسفات البحر الأحمر وتقوم هاتين الشركتين بانتاج خام الفوسفات المستخدم أساسا فى صناعة الأسمدة الفوسفاتية كما يتم تصدير كميات كبيرة منه وتقوم الشركتان بتشغيل عدد من المناجم بوادى النيل ومنطقة البحر الأحمر وتنتج بالاضافة الى الفوسفات خام التلك المستخدم فى صناعة الورق ومستحضرات التجميل والخزف والصينى والكاوتشوك والبلاستيك وخام المنجنيز فى الصناعات المعدنية والبطاريات والبويات وبعض الخامات المستخدمة فى عدد من الاغراض الصناعية مثل العزل وصناعة الحديد ومواد البناء والالوان والزجاج وهى خامات الاسيتوس والباريت والكوارتز والفلوسبار وكربونات الكالسيوم واكاسيد الحديد الحمراء والصفراء . وتبلغ قيمة الانتاج السنوى لهذا القطاع ٢ر٥٠٠ مليون جنيه ويبلغ عدد العاملين به ٦٩٤٠ عاملا .

واذ يبين هذا العرض المختصر العدد الكبير لمنتجات شركات المؤسسة والمجالات الواسعة لاستخداماتها .

فان المؤسسة وشركاتها توالى العمل على رفع الانتاج وتطويره متمشية مع احدث الانجازات العلمية والتكنولوجية لتحقيق رسالتها فى خدمة الصناعة والاقتصاد القومى .

النباتات الطبّية

ودور مؤسّسة الأدوية في تصنيعها

أولا : زراعة النباتات الزراعية

يوجد بمصر كثير من النباتات الطبية التى تنمو بريا والتى تجود أو قد تجود زراعتها بالبلاد وخاصة لما تتمتع به التربة المصرية من تعدد فى أنواعها من جيرية خفيفة الى طينية ثقيلة الى رملية من جهة وما يمتاز به مناخ معتدل فى الشمال الى حار فى الجنوب من جهة أخرى وبذلك يمكن اكثار وتهجين وتنويع كثير من الأصناف التى لها طلب عالمى بغرض تحسين الصنف للتصدير الى الخارج الا أنه توجد بعض الصعوبات والمعوقات ينبغى أن نتغلب عليها ولا نريد أن نذكر الصعوبات الفنية التى تقابل زراعة محاصيل جديدة لا يعلم المزارع العادى طرق أقلمتها وأنسب مواعيد زراعتها وتسميدها واكثارها وميعاد جمع المحصول وتسويقه وفى أى مكان تجود وما نوع المادة الفعالة اللازمة ومقدارها وفى أى جزء من النبات توجد وفى أى مرحلة أثناء النمو تتوفر وفى أى جزء من النبات توجد وفى أى مرحلة أثناء النمو تتوفر وفى أى وقت من الأوقات يمكن جمعها أو حصادها وكيفية تخزينها وطرق مكافحة الآفات التى تصيبها . . . الخ لأن كل ذلك لابد وأن تقوم به جهات على دراية وخبرة بالزراعة بوجه عام وبالنباتات الطبية بوجه خاص وتحتاج الى تقييم احصائى للنتائج الزراعية وبالتالى تحتاج الى تكرار فى مواسم محددة وزمن ليس بالقصير تحدده الأنواع المطلوب دراستها وعمر النبات .

والجهات التى تستطيع المساهمة فى تلك الدراسات فى حقول تجريبية كالآتى :

١ ــ كليات الصيدلة : جامعة القاهرة ، الاسكندرية ، أسيوط .
٢ ــ الكليات والمعاهد الزراعية ــ فى حقولها التجريبية .
٣ ــ وزارة الزراعة .
٤ ــ وزارة الاصلاح الزراعى .
٥ ــ هيئة تعمير الصحارى .
٦ ــ وزارة البحث العلمى .
٧ ــ مؤسسة الأدوية وشركاتها بالاضافة الى مركز الأبحاث والرقابة التابع لها .

وقامت المؤسسة عن طريق مركز الأبحاث والرقابة منذ مدة بمحاولة للتنسيق بين البعض من هذه الجهات وذلك بالاشتراك مع كلية الصيدلة جامعة القاهرة ويمكن القول بأنه قد تكونت خبرة كافية من الممارسة الفعلية وظهرت الجهود المتفوقة التى نرجو أن توحد داخل اطار عام له هدف محدد .

ومن أهم الصعوبات عدم وجود الكفايات والخبرات اللازمة بالاضافة الى صعوبة استيراد بعض أنواع البذور من الخارج لمحاولة زراعتها وأقلمتها .

أما بالنسبة لمعوقات التصدير فنترك مناقشة سياستها لارتباطها بخطة التنمية للدولة وسنكتفى بتوضيح بعض الملاحظات العامة التى تتميز بها النباتات الطبية وحاصلاتها من معوقات عند التصدير اهمها :

١ ــ عدم وجود جهة محددة مسئولة عن خطة مدروسة لتنفيذها فى اطار برنامج زمنى محدد مع القيام بالأعمال الكفيلة بتحقيق هذه الخطة من اتصالات منظمة بالمستوردين بالخارج لعمل دراسة للأسواق بها والتعرف على الاحتياجات الفعلية من أصناف معينة والتعاقد مع كل منها ووفاء هذه العقود .

ويهمنا أن نذكر أن التصدير الحالى يعتمد على بعض مصدرى القطاع الخاص الذين مارسوا زراعة بعض الأنواع من هذه النباتات وخاصة العطرية منها كهواية بقصد تحسين دخولهم وتعتبر هذه الاتصالات عفوية غير منظمة وتهدف الى تحقيق الصالح الخاص قبل العام .

٢ ــ عدم ثبات مستوى الصنف بمعنى أن لهذه النباتات مواصفاتها الدستورية العالمية المتفق عليها وتحتاج الى عناية خاصة وخبرة فنية قد لا تتوفر حاليا بالمستوى المطلوب .

والصور التى يتم التداول بها حاليا والأيدى التى تتداولها سواء من نباتات برية أو مزروعة لا يمكنها أن نقدم الضمانات الكافية للاحتفاظ بمستوى الصنف المطلوب وعلى سبيل المثال فقد فقدنا السوق العالمية لنبات السكران المصرى لوجود تذبذب مستمر فى مستواه الدستورى جعل المستوردين يتجهون الى غيره من النباتات ولو راعينا الطرق العلمية الحديثة لتحسين الصنف وحافظنا على مستواه لكان أحد مصادر العملة الصعبة لنا .

٣ ــ عدم توافر الكميات المطلوبة للتصدير باستمرار فى كل وقت وذلك يرجع فى أغلب الأحوال للظروف الخاصة بزراعة وتجارة هذه النباتات وحاصلاتها ونذكر منها :

(أ) الاستهلاك المحلى لها محدود وثابت تقريبا واستهلاكها الأساسى لا يكون بالتصدير .

(ب) المزارع المحلى لا يمكنه أن يقدم على زراعة أصناف جديدة لا يعلم نتائجها وتحتاج الى روح من المخاطرة لابد أن يقابلها ضمانات كافية وخاصة من ناحية ضمان تسويقها ولا يتم ذلك الا بتعاقد على شراء المحصول بثمن مجزى ويلزم لذلك دراسات للتكلفة .

(جـ) جمع وتجفيف وتخزين المحصول يحتاج فى أغلب الأحيان الى مساحات واسعة ومناشر خاصة غير متوفرة كما أن المخزون قد يكون عرضة للتلف وفقد المادة الفعالة مما يفقده قيمته من جهة وقد تفتك به الحشرات أو يصاب ببعض الفطريات التى تفسده نتيجة لسوء التخزين .

(د) من المخاطرة على المتجر العادى فى النباتات الطبية أن يتعاقد مع الزراع على الشراء للمحاصيل بهدف التخزين الى أن يطلبها المستورد أو المستهلك .

(هـ) طلبات الاستيراد غير واضحة أو محددة ولا تأتى الا تلقائيا عند أو « قبيل » ظهور المحصول بزمن قليل ولذلك نرى أن التصدير الحالى مبنى أساسا على النباتات البرية ويتم بطريقة عشوائية غير منتظمة .

من ذلك يتضح أن تصدير النباتات الطبية يجب أن تسبقه دراسات علمية سليمة لا يستطيع القيام بها الا مجموعة متكاملة

من الأفراد المدربين ذوى الخبرة فى هذا المجال فى اطار من الوضوح مع وجود سياسة هادفة الى التعاقد مع المستوردين بشروط مجزية قبل مواسم الزراعة بمدة كافية ويتم ذلك بعد عمل دراسات على أسعار السوق العالمية ومعرفة سعر التكلفة وتحديد سعر للتعاقد مع اجراء الاتصالات اللازمة مع المستهلكين العالميين وبطبيعة الحال لا يستطيع القطاع الخاص القيام بذلك بالصورة المطلوبة التى تحقق الغرض المرسوم .

ثانيا : استخلاص النباتات الطبية

يمكن قبل التعرض لموضوع استخلاص النباتات الطبية أن ننظر اليه من ناحيتين أساسيتين :

١ – انتاج الخلاصات الطبية السائلة والرخوة والجافة أو مركزاتها بقصد تغطية احتياجات السوق المحلية وتصدير

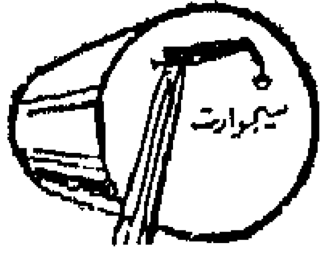
٢ – استخلاص المادة الفعالة الموجودة فى النباتات سواء أكانت الفائض وما يلزم ذلك من دراسات فنية لاختيار الأجهزة اللازمة ومعرفة تامة بخواص النباتات الطبية والمواد المذيبة والعمل على استبعاد المواد الذائبة التى اما أن تكون ذات تأثير طبى غير مرغوب فيه واما تكون عديمة المفعول الطبى كما يلزم تحديد أنسب الطرق وأبسطها لامكانيات الحصول على المواصفات الدستورية بأقل تكلفة وفى أسرع وقت ممكن وما يتبع ذلك من معرفة بأصول التخزين وظروفه للمحافظة على فاعليتها ويحتاج الى وجود خبرات فنية وكفاءات علمية على دراية تامة بطرق التقييم الكيماوية والبيولوجية للمطابقة على المواصفات .

قلويدات أو جلوكوسيدات أو زيوت طيارة ... الخ ويتبع فى ذلك احدى الطريقتين الآتيتين :

الطريقة المباشرة : وتجرى على النباتات الدستورية بعد طحنها وعجنها بالمذيب وتركيزها بعد الاستخلاص والطريقة غير مباشرة – وتتم على الخلاصات الدستورية باعتبار أن تحضير الخلاصة قد سبقته عدة دراسات للوصول الى أفضل طريقة لتركيز المواد الفعالة .

ويقع العبء الأكبر فى هذا المجال الحيوى على شركات **المؤسسة المصرية العامة للأدوية** لتوفيرها بصفة مستمرة فى السوق المحلية للاستعمال الجالينيى بشرط مطابقتها للمواصفات الدستورية ونذكر على سبيل المثال لا الحصر بعض الشركات التى تساهم فى ذلك :

١ – شركة النيل للأدوية .
٢ – الشركة العربية للأدوية .
٣ – شركة ممفيس الكيماوية .
٤ – شركة تنمية الصناعات الكيماوية .



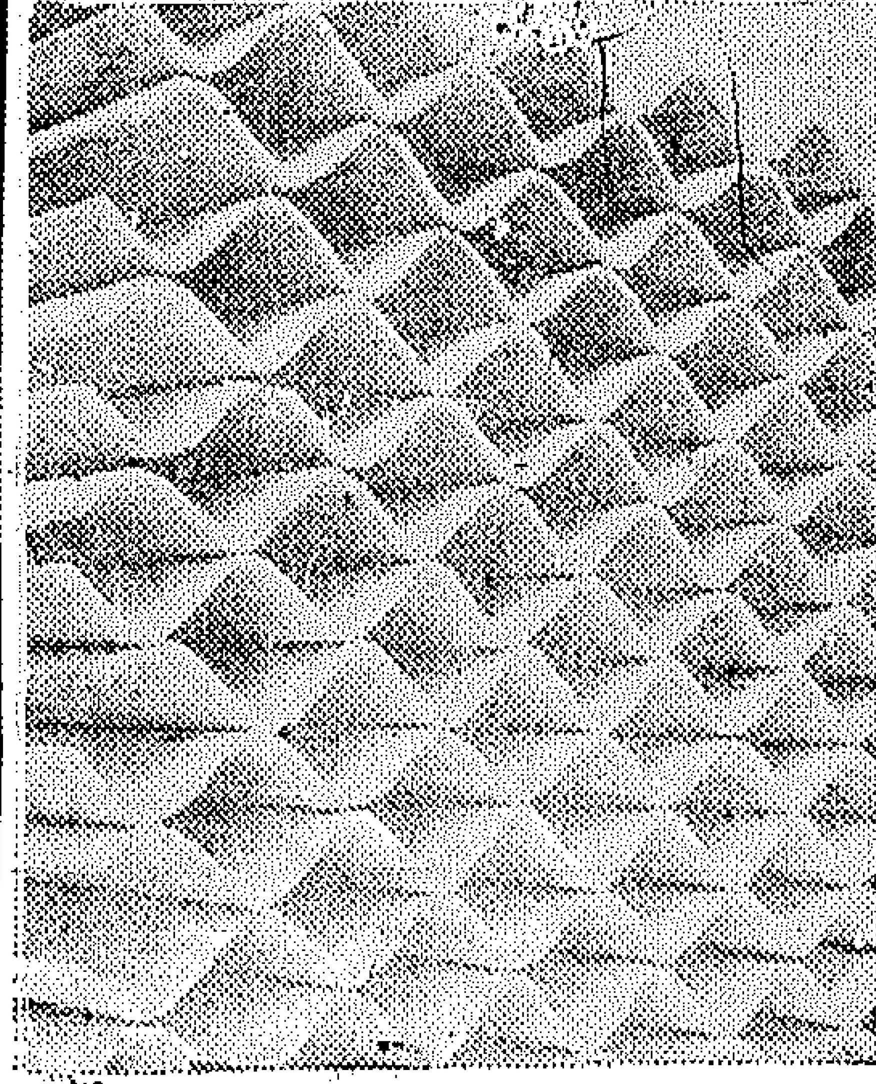
الشركة المصرية للمواسير والمنتجات الأسمنتية
« سيجوارت »

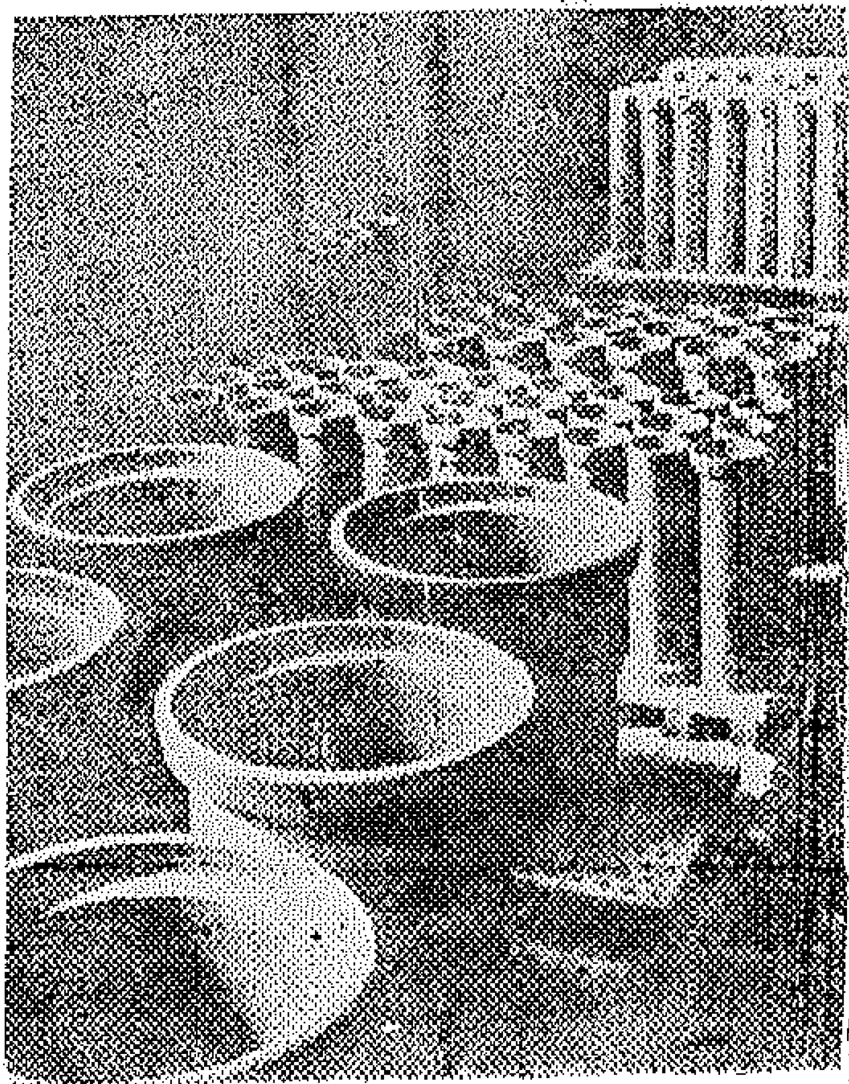
المركز الرئيسي : ١٥ شارع شريف بالقاهرة – تليفون : ٥٥٨٦٧ / ٥٣١٦٤ – برقياً : « سيجوارت »
المصانع : المعصرة/حلوان ت : ٣٨٣٨١ / ٣٨٠٠٢ • شبرا الخيمة : ت ٩٤٤٧١٣ / ٩٤٨٥٧١ • – الإسكندرية : ت : ٣٤٦٩١

ساهمت الشركة وتساهم بمنتجاتها المختلفة في كافة المشروعات العمرانية داخل الجمهورية وخارجها

منتجات الأسبستوس الأسمنتي

- المواسير الإسبستوس بأقطار حتى متر وبطول ٣، ٤، ٥ متر
- ألواح إسبستوس مضلعة عرض ١٠٥ سم بأطوال : ١٢٢، ١٥٢,٥، ١٨٣، ٢١٣,٥، ٢٤٤ سم
- ألواح إسبستوس مضلعة دائرية ١٠٥ X ٣٠٥ سم
- ألواح إسبستوس البلورد بدون أسمنت حسب الطلب
- ألواح إسبستوس مسطحة مقاس ١٢٠ X ١٢٢ سم


ASBESTOS CEMENT SHEETS.


STONEWARE PIPES

المنتجات الخرسانية والفخار المطلي

- المواسير الخرسانية المسلحة بأقطار حتى ٢ متر
- الأعمدة الخرسانية للإنارة وتوصيلات الكهرباء
- الفلنكات الخرسانية سابقة الإجهاد للسكك الحديدية باتساع ١٤٣,٥ متر وللخطوط الأخرى باتساع ١,٠ متر
- برابخ للكابلات التليفونات
- مواسير فخار للمجاري والصرف الصحي بأقطار حتى ٤٥ سم

وزيادة في مساهمة الشركة في كافة الأعمال العمرانية قامت بإنشاء إدارة عامة للتركيبات تقوم بتركيب مختلف منتجات الشركة طبقاً للأصول الفنية



شركة النصر لإنتاج الحراريات والفخار
« سورناجا »
SORNAGA

إحدى شركات المؤسسة المصرية العامة لمواد البناء والحراريات

إلى رجال الصناعة والأعمال

- حراريات عالية وسليكا ومجنزيت وكروم ...
- حراريات أفران صناعة الأسمنت
- مواسير فخار مطلي • أدوات صحية فاخرة
- زخارف للحمامات • أدوات منزلية
- طوب أزرق مغدني مقاوم للأحماض وطوب هندسي
- بلاط سيراميك ملون للأرضيات ومزجج للحوائط • كازات وتحف رسم يد

إنتاج جديد : بوادق صيني للمعامل • غلاف أجهزة قياس الحرارة للأفران

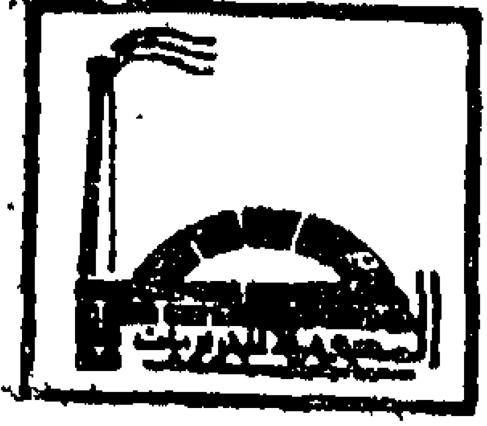




أكثر من ٧٠ عاماً في خدمة الصناعة العربية في الشرق الأوسط

المركز الرئيسي : القاهرة ٢٢ شارع قصر النيل ت : ٧٧٢٩٥ – ٧٧٢٩٦
كين بريد ١٦٥ القاهرة – تلغرافيا : « حراريات »
المصانع : الوديي – مركز الصف – جيزة ت : ٣٨٢٩٦
الفرع : الإسكندرية – ميدان سانت كاترين ص. ب : ٤٩٧
المصنع : ٢٢٨ شارع قنال المحمودية – تليفون : ٣٨٥٣٦
المعرض الدائم : ٣ ش إبراهيم القباني / المتفرع من ش قصر النيل – ناصية للابس بالقاهرة

قصة نجاح أكبر شركة حراريات في مصر



« الثقة » والثقة وحدها .. هى التى تعتبر من أهم مقاييس النجاح .. فى مجال الأعمال التى تقوم بها وتأخذها على عاتقها الشركات الكبرى فى العالم ...

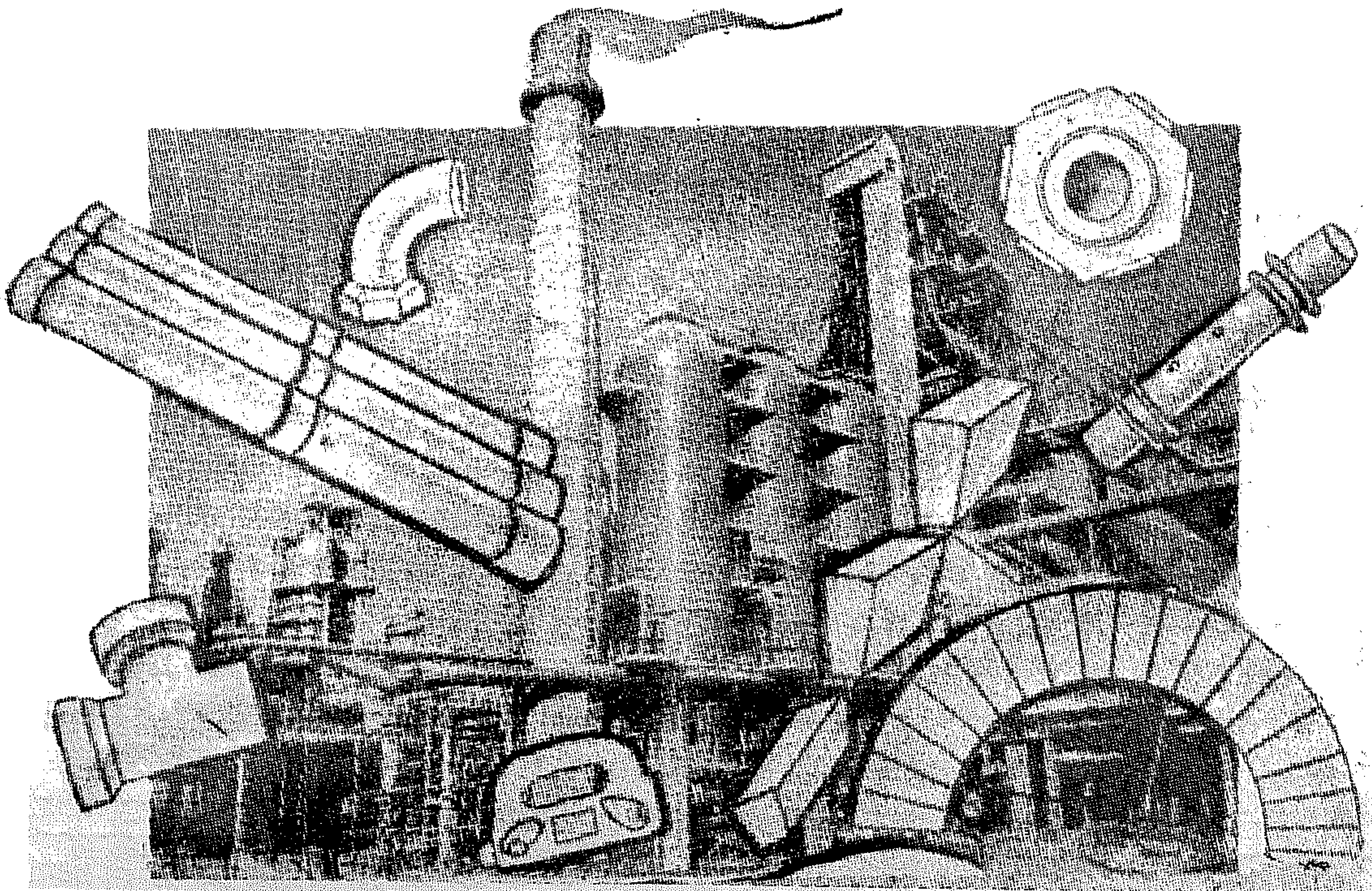
والثقة لا تأتى عفوا الى شركة من الشركات ... ان « الثقة » لا تحصل عليها الشركة الا بعد جهود شاقة متواصلة وبعد بذل الكثير من العرق والكفاح والاخلاص الشديد فى العمل .. ومن الجدير بالذكر أن هناك الكثير من الشركات فى العالم العربى استطاعت أن تحصل على هذه الثقة وأن تحافظ عليها نتيجة الصدق والكفاءة العالية وأن تصبح عنوانا للقدرة العربية والابتكار العربى ومن هذه الشركات ((**الشركة المصرية للحراريات**)) ...

والتى تفخر بأنها قد ساهمت بنصيب كبير فى الفرن العالى الثالث بمجمع الحديد والصلب الذى يعتبر القاعدة الأساسية للصناعات الثقيلة . اذ قامت بأعمال التبطين بالطوب الحرارى اللازم لبناء الفرن الثالث وملحقاته وكذلك مسخنات الهواء به ..

وتواصل الشركة تقدمها وتطورها مراعية فى انتاجها أحدث التطورات التكنولوجية فى التصنيع .. كما تقوم بامداد العديد من الصناعات المختلفة بحاجتها من الحراريات ومنها صناعة الحديد والصلب والصناعات المعدنية وصناعة الاسمنت والزجاج والبللور والصناعات الغذائية والكيماوية وغيرها بالاضافة الى ذلك فان الشركة تساهم فى دعم صناعة الحراريات والخزفيات وتغطية احتياجات البلاد حيث تنتج :

- الحراريات ذات الأبعاد القياسية ، والقطع المخصوصة والطين النارى الألومينى .
- الطوب الأزرق والمنتجات السيراميكية .
- البرابخ بأقطارها المختلفة من ٤ بوصة حتى ١٢ بوصة وملحقاتها .
- الخزفيات وجميع المنتجات المقاومة للأحماض .
- العوازل الكهربائية بأشكالها المختلفة (خطوط مختلفة ومتوسطة الى ٣٣٫٠٠٠ فولت) .
- الجبس الأبيض الناعم الممتاز .
- الطوب العازل للحرارة بكافة انواعه وأشكاله كما يوجد بالشركة قسم متخصص فى تصميم وبناء الأفران الصناعية والأعمال المقاومة للأحماض .

هذه هى **الشركة المصرية للحراريات** احدى شركات المؤسسة المصرية العامة لمواد البناء والحراريات والصورة المشرقة لمصر العربية بذلا وتعاونا ودعما على طريق الحياة الأفضل .. انها ترفع علم النهضة الصناعية وترسم بانتاجها صورة حية للتقدم الصناعى فى بلادنا ...



التصنيع والانتاج

جمعية المهندسين الكهربائيين
والالكترونيين
جمعيــة الهندســة الادارية
جمعية المهندسين الميكانيكيين

(iii) A Supreme Committee having among its members representatives from; the Academic Boards, the industrial establishments, and from the planning authorities, will have the responsibility of defining the role of the different engineering levels in the engineering pattern, setting up the standards which each type has to achieve, and most importantly to draw the attention of the curriculum committee and Academic councils for the future needs in engineering courses and personnel.

BASIC CONCEPTS IN SETTING UP THE CURRICULUM AND ESTABLISHING THE SYLLABI :

In fact the education of an engineer must proceed in three fronts simultaneously :

(1) The acquisition of the theoretical and practical knowledge, (theoretical and practical content of the syllabus).

(2) The acquisition of skill and confidence in industrial situations.

(3) The acquisition of skill and knowledge in the field of management and Human Relations.

All engineering courses require a certain balance of these three functions in varying degree. For example, at craft level item "2" is the pre-eminent, while item "1" is only necessary as related to item "2", also item "3" is just required to provide an appreciation of management problems. A high level technician requires items 1 & 2 in equal proportions, and item 3 as a tool for his own development as a supervisor. For an engineer item 1 will provide the basic formulation of the engineer, item 2 will be required to provide a sound understanding of the industrial processes as related to item 1, while item 3 will be given enough attention to fulfil its role in the formulation of the engineer anticipated personality.

It should be noted that the basic sciences should be provided in a directly applied way and not in the traditionally academic fashion. It should be related to the real problems of engineering.

Once these basic concepts are taken into account, a planner can start drawing up the skeleton of the syllabus based on his own experience, the country needs and aims, and the initial conditions. At each stage in the syllabus development, one should ask: What is the topic for? It is consistent with the end to be achieved?, How does the topic relate to the other subjects? Is the work duplicated in any way?.

A further thought should be given to the number of subjects involved, they should be kept to a minimum and closely related subjects can be grouped under new headings.

After the main lines of the syllabus have been established one should not forget that a well formulated syllabus requires efficient laboratory practice; which means **well - equipped, well organized laboratories** with qualified laboratory assistance. It should be also noted that trying to economize in establishing engineering laboratories would result in a deficient enviroment for engineering education, besides, it will add to the problem of high drop out rate. In highly industrialized countries the work - place in industry or engineering establishment has provided a suitable enviroment which helps the formation of their engineer. That is why, **in developing countries, engineering laboratories and workshop facilities should be given the upmost support to provide the suitable enviroment required for engineering education.**

An example for a well - designed syllabus with well planned laboratories, where all the above concepts were observed, was established by the auther while he was performing his duties as a UNESCO Expert building up the Electrical Power Engineering Department in the Technological Institute of Damascus, Damascus University.

would be as ineffective as a computer without an operator.

Besides, the lack of such knowledge will not help the engineer to press his cause or present himself to the public in a favourable light. His counterparts in economics, law and arts suffer no such inhibitions and are able to push themselves even regardless of ability. Thus, when it comes to the stage of leadership, management, or planning, the engineer may find himself at the mercy of his more extrovert collegues of economics and law. A situation which will never help the industrial development of a developing country.

Thus, every engineering curriculum should contain an adequate part of knowledge in the field of Human Relations, Economics, Management, and Community Planning; in order to provide the country with the engineering personnel who definitly will be of a more active role in the society.

ENGINEERING EDUCATION AND TECHNOLOGICAL GROWTH

Technology is not a static thing. What may be regarded as the whole body of existing knowledge is factual, but from it we must select carefully to achieve a given objective. Engineers with inappropriate education will be ultimately non - productive, and their presence in the engineering pattern will even constitute a retarding effect on the technological growth in the country. This growth will be always needing new areas in the field of scientific and engineering education, and therefore, the curriculum and syllabus must continously reflect this demand. Fields of nuclear energy, transistors, integrated circuits, large electrical machines, and extra high voltage transmission are just few examples.

Thus for the engineering education to match the rate of technological growth, a certain feed - back between the technology and the education should exist. In plain words, engineering education should reflect a sound integration of practical and theoritical training, and links should be established between the engineering educational establishments and the industries.

This can be achieved as follows:

(i) In the final years of education more emphasis should be given to projects of industrial nature directly connected to the development projects in the country. Engineers from the industry and engineering establishments should participate in the supervision of such projects.

(ii) Joint Committees between the industrialists, and the academic staff have to be established for **continous curriculum review and development.** This committee (which is not a Faculty Council) will be also responsible for investigating the other systems of engineering education in the different countries. Also the committee have to continously make a follow up for the engineers after their graduation to see how far the curriculum is matching the technological needs of the country. Addition can be made to the syllabi or unrelavent material can be ommitted.

Besides, specialized sub-committees can be established to set up curriculums and syllabi for **further - education** for engineers. (This should not be mixed with post - graduate courses leading to university degrees).

Also for the other levels of the engineering pattern, a similar task can be accomplished.

ENGINEERING EDUCATION AND THE TECHNOLOGICAL GROWTH IN DEVELOPING COUNTRIES

BY

DR. S. M. EL-SOBKI

INTRODUCTION

When dealing with the question of Engineering or Technological Education in developing countries, we should first define the aim and purpose of that type of education, as well as the function of the establishments in which such education will take place. Precisely, and in brief, engineering education must provide for the **technological growth** of the country through the provision of suitably trained man - power at all levels. Besides, the function of the Engineering Institutions and the associated Educational Administration should create an enviroment in which such education will take place most efficiently.

It follows, that when planing engineering education, the following points should be considered thoroughly:

(i) The type and level of secondary school education existing in the country.

(ii) The future **industrial potential,** and how far the country is ready for a technological revolution.

(iii) What are the restraints imposed by the current pattern of social and political establishments.

(iv) The man - power needs of the country at the different levels of the engineering pattern.

One should also point out, that as long term planning is quite difficult in developing countries, we usually find that Engineering Educational Establishments, (Faculties of engineering, Technological Institutes, and Technical colleges), are set up to find themselves in competition and **without clearly defined role** in the development plan of the country. This diffculty does not exist, to that extent, in highly industrialized countries where a certain feed - back takes place between the well developed industries and the engineering education, and helps the formulation of the Engineering Pattern.

Another question will also rise, when planning engineering education in developing countries, about how far should such education be related to the immediate present needs of the country and how far should it provide for future development. This question can have a profond effect on both the curriculum and syllabus.

ENGINEERING EDUCATION AND THE SOCIETY

Higher education in general, by its very nature is selective and specialized. It is not applied to the masses on a compulsory basis, and in order to survive, it must directly consider its aim and purpose in relation to both industry and society. The engineer is a social entity, he needs to work with and through people, and he must understand the complexities of the real world in both economic and human terms. Without this understanding, an engineer

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The equation (34.b) is usually shorted as:

$$\Psi_{mq} s = X_q(s)\, i_{mq}(s) + c_{oq}(s) \qquad (34.c)$$

Where

The picture transversal reactance.

$$X_q(s) = \left(X_q - \frac{s X_{xtq}}{R_{tq} + s X_{ttq}} \right) \frac{10^8}{\omega_s} \qquad (34.d)$$

The pictures of beginning limits of the transversal position.

$$c_{oq}(s) = \left(\frac{X_{xtq}\, i_{mq}(0) + X_{xtq} X_{ttq}\, i_{tq}(0)}{R_{tq} + s X_{ttq}} \right) \frac{10^8}{\omega_s} \qquad (34.e)$$

All these equations are the fundamental equations for problems, which we must in our next work.

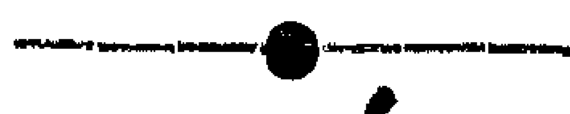
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R_{tq} The resistance of the damper winding in the transversal position.

i_{tq} The current of the damper winding in the transversal position.

i_{mq} The project of the stator current in axis q.

φ_{tq} The leakage flux with the damper winding in transversal position.

φ_{mq} The leakage flux with the stator winding in transversal position..

X_{ttq} The correspond reactance to the self inductance of damper winding in transversal position.

X_{xtq} The correspond reactance to the mutual inductance of stator & damper winding in transversal position.

X_q The correspond reactance to the self inductance of stator winding in transversal position.

By substuti equation (31.b) into equation (31.a) we get.

$$\varnothing = R_{tq}\, i_{tq} + \frac{d}{dt_v}\left(X_{xtq}\, i_{mq} + X_{ttq}\, i_{tq}\right)\frac{1}{\omega_s} \qquad (32.a)$$

The corresponding Laplace's picture.

$$\varnothing = R_{tq}\, i_{tq}(s) + s\left[X_{xtq}\, i_{mq}(s) + X_{ttq}\, i_{tq}(s)\right] - \left[X_{xtq}\, i_{mq}(0) + X_{ttq}\, i_{tq}(0)\right] \qquad (32.b)$$

we used again the equations (22.a) & (22.b).

From equation (32.b)

$$i_{tq}(s) = \frac{-sX_{xtq}}{R_{tq} + sX_{ttq}}\, i_{mq}(s) + \frac{X_{xtq}\, i_{mq}(0) + X_{ttq}\, i_{tq}(0)}{R_{tq} + sX_{ttq}} \qquad (33)$$

The laplace's picture of equation (31.c).

$$\varphi_{mq}(s) = \frac{1}{\omega_s}\left[X_q\, i_{mq}(s) + X_{xtq}\, i_{tq}(s)\right]10^8 \qquad (34.a)$$

By putting the exprision (33) we get.

$$\varphi_{mq}(s) = \left\{\left[X_q - \frac{s X_{xtq}^2}{R_{tq} + sX_{ttq}}\right] i_{mq}(s) + \frac{X_{xtq}\, i_{mq}(0) + X_{xtq} X_{ttq}\, i_{tq}(0)}{R_{tq} + sX_{ttq}}\right\}\frac{10^8}{\omega_s} \qquad (34.b)$$

$$= R_f R_{td} + s(R_{td} X_{ff} + R_f X_{ttd}) + s^2(X_{ff} X_{ttd} - X_{ftd}^2) \qquad (29.d)$$

The equ. (29.c) is shorted in the expression

$$\psi_{md}(s) = \left[g_d(p)\mu_f(s) + x_d(p) i_{md}(s) + c_{od}(p)\right] \frac{10^8}{\omega_s} \qquad (30.a)$$

The meaning of each member we get after the companing equations (29.c) and (30)

The picture of admitance.

$$g_d(p) = \frac{R_{td} X_{xf} + s(X_{ttd} X_{xf} - X_{xtd} X_{ftd})}{R_f R_{td} + s(R_{td} X_{ff} + R_f X_{ttd}) + s^2(X_{ff} X_{ttd} - X_{ftd}^2)} \frac{10^8}{\omega_s} \qquad (30.b)$$

The picture of longitudinal reactance

$$x_d(p) = x_d - \frac{s(R_{td} X_{xf}^2 + R_f X_{xtd}^2) + s^2(X_{xf}^2 X_{ttd} + X_{ff}^2 X_{xtd} - 2X_{xtd} X_{xf})}{R_f R_{td} + s(R_{td} X_{ff} + R_f X_{ttd}) + s^2(X_{ff} X_{ttd} - X_{ftd}^2 X_{ftd})} \cdot \frac{10^8}{\omega_s} \qquad (30.c)$$

The picture member of the begining limits for the longitudinal position

$$c_{od}(p) = \left\{ \frac{X_{xf}[X_{ff}(R_{td} + sX_{ff}) - sX_{ftd}^2] + X_{xtd}[(R_f + sX_{ff})X_{ftd} - sX_{ftd}X_{ff}]}{\Delta} i_f(0) + \right.$$

$$+ \frac{X_{xd}[(R_{td} + sX_{ff})X_{ftd} - sX_{ftd}X_{ttd}] + X_{xtd}[(R_f + sX_{ff})X_{ttd} - sX_{ftd}^2]}{\Delta}$$

$$i_{td}(0) + \frac{X_{xf}[(R_{td} + sX_{ff})X_{xf} - sX_{ftd} X_{xtd})] + X_{xtd}[R_f + sX_{ff}) \cdot}{\Delta}$$

$$\left. \frac{X_{xtd} - sX_{ftd} X_{xf}]}{\Delta} i_{md}(0) \right\} \frac{10^8}{\omega_s}$$

e: The relations of synchronous machine with a damper winding for a transversal position.

The magnetic axis of an field winding is perpendicular to the transversal position.

For the coupling of stator and damper winding, we can write similar to equations (16) and (17)

$$\mu_{tq} = 0 = R_{tq} i_{tq} + \frac{d\psi_{tq}}{dt} 10^{-8} \qquad (31.a)$$

$$\psi_{tq} = \frac{1}{\omega_s}(X_{ttq} i_{tq} + X_{xtq} i_{tq}) 10^8 \qquad (31.b)$$

$$\psi_{mq} = \frac{1}{\omega_s}(X_q i_{mq} + X_{xtq} i_{tq}) 10^8 \qquad (31.c)$$

$$i_{td} = -\frac{sX_{ftd}}{\Delta}\mu_f(s) + \frac{s^2[X_{xf}X_{ftd} - X_{ff}X_{xtd}] - sR_f X_{xtd}}{\Delta} i_{md}(s)$$

$$+ \frac{(R_f + sX_{ff})X_{ttd}\, i_{td}(0) + X_{ftd}\, i_f(0) + X_{xtd}\, i_{md}(0)}{\Delta}$$

$$\frac{sX_{ftd}\, X_{ff}\, i_f(0) + X_{ftd}\, i_{td}(0) + X_{xf}\, i_{md}(0)}{\Delta} \qquad (28.b)$$

Now Laplace's transformation of a relation (25.a)

$$\psi_{md}(s) = \mathcal{L}\left[\frac{1}{\omega_s}(X_d i_{md} + X_{xf} i_f + X_{td} i_{td})\right]10^8$$

and of the L. transformation.

$$\psi_{md}(s) = [X_d\, i_{md}(s) + X_{xf} i_f(s) + X_{xtd}\, i_{td}(s)]\frac{10^8}{\omega_s} \qquad (29.a)$$

By substituting equations (28.a) and (28.b) into the last equation, we get the picture of relation ψ_{md} as a function i_{md}, μ_f :

$$\psi_{md}(s) = -F[i_{md}(s)\,\mu_f(s), i_f(0), i_{td}(0), i_{md}(0)] \qquad (29.b)$$

After this mathematic operation and after arrangement will be.

$$\psi_{md}(s) = \Big\{\Big[\frac{X_{xf}R_{td} + s(X_{ttd}X_{xf} - X_{xtd}X_{ftd})}{\Delta}\Big]\mu_f(s) +$$

$$\Big[\frac{X_d - sR_{td}fX_x + s^2X_{xf}^2 X_{ttd} - X_{xtd}X_{ftd}X_{xf} + sR_f X_{xtd}^2 +}{\Delta}$$

$$\frac{s^2(X_{ff}^2 X_{xtd} - X_{xf}X_{ftd}X_{xtd})}{\Delta}\Big] i_{md}(s) +$$

$$\frac{X_{xf}[(R_{td} + sX_{ff})X_{ff} - sX_{ftd}] + X_{xtd}[(R_f + sX_{ff})X_{ftd} - sX_{ftd}X_{ff}]}{\Delta} i_f(0) +$$

$$\frac{X_{xf}[(R_{td} + sX_{ff})X_{ftd} - sX_{ftd}X_{ttd}] + X_{xtd}[(R_f + sX_{ff})X_{ttd} - sX_{ftd}]}{\Delta}.$$

$$i_{td}(0) + \frac{X_{xf}[(R_{td} + sX_{ff})X_{xf} - sX_{ftd}X_{xtd}] + X_{xtd}[(R_f + sX_{ff})X_{xtd} -}{\Delta}$$

$$\frac{sX_{ftd}X_{xf}]}{\Delta}\, i_{md}(0)\Big\}\frac{10^8}{\omega_s} \qquad (29.c)$$

Where: $\Delta = \begin{vmatrix} R_f + sX_{ff} & sX_{ftd} \\ sX_{ftd} & R_{td} + sX_{ttd} \end{vmatrix} =$

(The beginning quantities are not zero)

$$\mu_f(s)=R_f \cdot i_f(s)+s[X_{ff} \cdot i_f(s)+X_{ftd} \cdot i_{td}(s)+X_{xf}\, i_{md}(s)]-[X_{ff} \cdot i_f(\emptyset)+X_{ftd} \cdot i_{td}(\emptyset)+X_{xf} \cdot i_{md}(\emptyset)] \qquad (26.a)$$

$$(\emptyset)=R_{td} \cdot i_{td}(s)+s[X_{ttd} \cdot i_{td}(s)+X_{ftd} \cdot i_f(s)+X_{xtd}\, i_{md}(s)]-[X_{ttd} \cdot i_{td}(\emptyset)+X_{\ td} \cdot i_f(\emptyset)+X_{xtd} \cdot i_{md}(\emptyset)] \qquad (26.b)$$

From these equations we can get Laplace's pictures of currents

$$(R_f+sX_{ff})\, i_f(s)+sX_{ftd} \cdot i_{td}(s)=\mu_f s-sX_{xf} \cdot i_{md}(s)+X_{ff} \cdot i_f(\emptyset)+X_{ftd} \cdot i_{td}(\emptyset)+X_{xf} \cdot i_{md}(\emptyset)=A \qquad (27.a)$$

$$sX_{ftd} \cdot i_f(s)+(R_{td}+sX_{ttd})\, i_{td}(s)=-sX_{xtd}\, i_{md}(s)+X_{ttd} \cdot i_{td}(\emptyset)+X_{ftd} \cdot i_f(\emptyset)+X_{xtd} \cdot i_{md}(\emptyset)=B \qquad (27.b)$$

$$i_f(s)=\frac{\begin{vmatrix} A & sX_{ftd} \\ B & (R_{td}+sX_{ttd}) \end{vmatrix}}{\begin{vmatrix} (R_f+sX_{ff}) & sX_{ftd} \\ sX_{ftd} & (R_{td}+sX_{ttd}) \end{vmatrix}} \qquad (27.c)$$

$$i_{td}=\frac{\begin{vmatrix} (R_f+sX_{ff}) & A \\ sX_{ftd} & B \end{vmatrix}}{\begin{vmatrix} (R_f+sX_{ff}) & sX_{ftd} \\ sX_{ftd} & (R_{td}+sX_{ttd}) \end{vmatrix}} \qquad (27.d)$$

From the last equations

$$i_f(s)=\frac{R_{td}+sX_{ttd}}{\Delta}\mu_f(s)+\frac{s^2(X_{xtd}X_{ftd}-X_{xf}X_{ttd})-sR_{td}X_{xf}}{\Delta}i_{md}(s)$$

$$+\frac{(R_{td}+sX_{ff})[X_{ff}\, i_f(0)+X_{ftd}\, i_{td}(0)+X_{xf}\, i_{md}(0)]}{\Delta}-$$

$$\frac{sX_{ftd}[X_{ttd}\, i_{td}(0)+X_{ftd}\, i_f(0)+X_{xtd}\, i_{md}(0)]}{\Delta} \qquad (28.a)$$

The leakage flux of an field winding in a longitudeal position is made by a contribution of an own field winding and by the contributions of the damper winding and stator winding.

$$\psi_f = \frac{1}{\omega_S}\left[X_{xf} \cdot i_f + X_{xtd} \cdot i_{td} + X_d \cdot i_{md}\right] 10^8 \qquad (25.b)$$

The leakage flux of the damper winding in longitudinal position is made by a contribution of an own winding and by the contributions of an field winding and stator winding.

$$\psi_{td} = \frac{1}{\omega_S}\left[X_{ttd} \cdot i_d + X_{ftd} \cdot i_f + X_{xtd} \cdot i_{md}\right] 10^8 \qquad (25.c)$$

Where:

X_{xf} The reactance correspond to the mutual inductance (stator and field winding).In longitudinal position.

X_{xtd} The reactance correspond to the mutual inductance (stator and damper winding).

X_d The reactance correspond to the self-inductance of stator winding in longitudinal position.

X_{ff} The reactance correspond to the self inductance of field winding.

X_{ftd} The mutual indictances of field and damper winding in longitudinal position.

X_{ttd} The mutual inductances of the damper winding in longitudinal position.

The expressions (25.b)and(25.c)are substituted into equations (24.a)and(24.b).

$$u_f = R_f \, i_f + \frac{1}{\omega_S} \frac{d}{dt_r}\left(X_{ff} \cdot i_f + X_{ftd} \cdot i_{td} + X_{xf} \cdot i_{md}\right)$$
$$0 = R_{td} i_{td} + \frac{1}{\omega_S} \frac{d}{dt_r}\left(X_{ttd} i_{td} + X_{ftd} i_{ftd} + X_{xtd} i_{md}\right)$$

The correspond Laplace's pictures will be with conditions (22.a) and (22.b):-

d: The relations of synchronous machine with a damper winding for a longitudinal position :

For expression of a situation on the rotor we use the relation (16).

In the circuit of field winding.

$$\mu_f = R_f . i_f + \frac{d\psi_f}{dt_y} 10^{-8} \qquad (24.a)$$

In the circuit of damper winding

$$\theta = R_{td} i_{td} + \frac{d\psi_{td}}{dt_y} 10^{-8} \qquad (24.b)$$

Where:

μ_f The voltage on the terminal of the field winding.

R_f The resistance of the field winding.

R_{td} The resistance of the damper winding in longitudinal situation position.

i_{td} The current in the damper winding in longitudinal position.

i_f The current in the field winding.

ψ_f A leakage flux with the field winding.

ψ_{td} A leakage flux with the damper winding for a longitudinal position.

Besides the equation for voltage, we can write by using equation (17) the relations for leakage fluxes with individual windings of machine, which has the damper winding on the rotor.

The expresions are relating to a longitudinal position, the leakage flux of a stator winding in an longitudinal position is made by a contribution of own Stator's winding, by a contribution of an field winding and by a contribution of the damper winding

$$\psi_{md} = \frac{1}{\omega_s} [X_{xf} \ i_f + X_{xtd} \ i_{td} + X_d \ i_{md}] 10^{8} \qquad (25.a)$$

$$\mu md = R_X\, i_{md} + \frac{d\psi_{md}}{dt_r} - \psi_{md} wr \qquad (20.a)$$
$$\mu mq = R_X\, i_{mq} + \frac{d\psi_{mq}}{dt_r} - \psi_{mq} wr \qquad (20.b)$$
$$\mu_o = R_X\, i_X + \frac{d\psi_o}{dt_r} \qquad (20.c)$$

The value $\frac{d\phi}{dt_r} = \omega r$ means the angle-velocity of the rotor.

Let us suppose the constant angle-velocity of the rotor by transients.

This velocity must be not identical with the synchronous one.

$$\omega r \neq \omega s$$

For inquiry of Laplace's transformation of equations (20.a), (20.b), and (20.c).

We suppose that the beginning limits are not zero.

We shall use for the time the relation of a variable t:

$$t = \omega_S \cdot t_r \qquad (22.a)$$

Where: t_r *the time in second*

ω_S *angl synchronous velocity rad. per second.*

t *the time in radins*

By the fundamental rules about Laplace's transformation we get:

$$\mathcal{L}\left(\frac{d f(t)}{dt}\right) = s\mathcal{L}(f(t)) - f(o)$$
$$= s\, f(s) - f(o) \qquad (22.b)$$

By substituting the equation (22.a) into equation (20) and by using laplace transformation we get:

$$\mu md(s) = R_X\, imd(s) + \omega_S\, [s\,\psi md(s) - \psi md(\theta)] . 10^{-8}$$
$$- \omega_r\, \psi mq(s) . 10^{-8} \qquad (23.a)$$
$$\bar{\mu} mq(s) = R_X\, imq(s) + \omega_S\, [s\,\psi mq(s) - \psi mq(\theta)] . 10^{-8}$$
$$- \omega_r\, \psi md(s) . 10^{-8} \qquad (23.b)$$
$$\mu_o(s) = R_X\, i_o(s) + \omega_S [s\,\psi_o(s) - \psi_o(\theta)] \qquad (23.c)$$

Where: u_k the voltage of the K^{th} phase.
i_k the current of the K^{th} phase.
ψ_k the flux of the K^{th} phase.
The relation for the value of

$$u = \sum_{l=1}^{l=n} L_{kl} \cdot i_l = \frac{1}{\omega} \sum_{1}^{n} X_{kl} \cdot i_l \qquad (17)$$

c. Derivation of further relations of the voltage values:

By equations (15) about the current, we can write also for the voltage of the phase x.

$$u_x = u_{md} \cos\phi - u_{mq} \sin\phi_0 \qquad (18)$$

The same for leakage flux.

$$\psi_x = \psi_{md} \cos\phi - \psi_{mq} \sin\phi_0 \qquad (19)$$

The first derivatives: (the time t in second).

$$\frac{d\psi_x}{dt_y} = \cos\phi \frac{d\psi_{md}}{dt_y} + \psi_{md} \frac{d\cos\phi}{dt_y} - \psi_{mq} \frac{d\sin\phi}{dt_y} - \sin\phi \frac{d\psi_{mq}}{dt_y} + \frac{d\psi_0}{dt_y}$$

$$= \cos\phi \frac{d\psi_{md}}{dt_y} - \psi_{md} \sin\phi \frac{d\phi}{dt_y} - \psi_{mq} \cos\phi \frac{d\phi}{dt_y} - \frac{d\psi_{mq}}{dt_y}$$

$$+ \frac{d\psi_0}{dt_y} \qquad (19.a)$$

For the phase we use the equation (16) where instead of i_x from equation (15); instead of $\frac{d\psi_x}{dt_y}$ from (19.a) instead of u_x from (18)

After preparation we get:

$$u_{md} \cos\phi - u_{mq} \sin\phi + u_0 = u_x =$$

$$= R_x i_{md} + \frac{d\psi_{md}}{dt_y} - \psi_{mq} \frac{d\phi}{dt_y} \cos\phi - R_x i_{mq} + \psi_{md} \frac{d\phi}{dt_y} + \frac{d\psi_{mq}}{dt_y}$$

$$\sin\phi + R_x i_0 + \frac{d\psi_0}{dt_y} \qquad (20)$$

By comparing the corresponding nombers of equation (20) it will be:

The last value of I_{x_1} is the same result as equation (7.a)

By the same way, the project of I_{m_1} on the axis Y and Z are equals to I_y and I_z equations (7.c) and (7.e).

$$Ix_1 = I_{md_1} \cos\phi - I_{mq} \sin\phi \qquad (13.a)$$

$$Iy_1 = I_{md_1} \cos(\phi - \tfrac{2}{3}\pi) - I_{mq_1} \sin(\phi - \tfrac{2}{3}\pi) \qquad (13.b)$$

$$Iz_1 = I_{md_1} \cos(\phi + \tfrac{2}{3}\pi) - I_{mq_1} \sin(\phi + \tfrac{2}{3}\pi) \qquad (13.c)$$

Similarly we can write the equations for the vector of a inverse system,

$$|\hat{I}m| = \sqrt{I_{md}^2 + I_{mq}^2} = I_m$$

By the same way it will be:

$$Ix_2 = I_{md_2} \cos\phi - I_{mq_2} \sin\phi \qquad (14.a)$$

$$Iy_2 = I_{md_2} \cos(\phi - \tfrac{2}{3}\pi) - I_{mq_2} \sin(\phi - \tfrac{2}{3}\pi) \qquad (14.b)$$

$$Iz_2 = I_{md_2} \cos(\phi + \tfrac{2}{3}\pi) - I_{mq} \sin(\phi + \tfrac{2}{3}\pi) \qquad (14.c)$$

On the base of equations (13 and 14) it is possible to compare with equations (3 and 6).

$$Ix = Ix_1 + Ix_2 + Ix_0$$

$$= I_{md} \cos\phi - I_{mq} \sin\phi + Ix_0 \qquad (15.a)$$

$$Iy = I_{md} \cos(\phi - \tfrac{2}{3}\pi) - I_{mq} \sin(\phi - \tfrac{2}{3}\pi) + Ix_0 \qquad (15.b)$$

$$Iz = I_{md} \cos(\phi + \tfrac{2}{3}\pi) - I_{mq} \sin(\phi + \tfrac{2}{3}\pi) + Ix_0 \qquad (15.c)$$

We can derived from analysis the last equation that the solution of the vector $\bar{I}_{m_1}$ has the synchronous velocity with a positive direction.

The relation of vector $\bar{I}_{m_2}$ has the synchronous velocity with a negative direction.

What we write about values of a current and their projections into axis d and q, we can write the same about a voltage, E.M.F., M.M.F., and about magnitic-fluxes, for our next work we use the known relation about the induce voltage

$$\mu_k = R\, i_k + \frac{d\psi_k}{dt} 10^{-8} \qquad \text{volt} \qquad (16)$$

By substituting with equation (10) into equations (9) with conditions:

$$\cos(+\alpha) = +\cos(-\alpha)$$
$$\sin(-\alpha) = -\sin(+\alpha)$$

we get:

$$I_{md_1} = +\tfrac{3}{2}\lambda I_{m_1} \cos(\phi_1 + \phi_0) \qquad (11.a)$$
$$I_{md_2} = +\tfrac{3}{2}\lambda I_{m_2} \cos(2wt - \phi_2 + \phi_0) \qquad (11.b)$$
$$I_{mq_1} = -\tfrac{3}{2}\lambda I_{m_1} \sin(\phi_1 + \phi_0) \qquad (11.c)$$
$$I_{mq_2} = -\tfrac{3}{2}\lambda I_{m_2} \sin(2wt - \phi_2 + \phi_0) \qquad (11.d)$$

The vector whose projections into axis d and q equal I_{md} and I_{mq}, is called the picture of the vector $\hat{I}_{m_1}$ of the direct system

$$\left|\hat{I}_{m_1}\right| = \sqrt{I^2_{md_1} + I^2_{mq_1}} = \tfrac{3}{2}\lambda I_{m_1} \qquad (12.a)$$

When I_{m_1} is the amplitude of the current on the direct system this can be known after the substituting equations (11.a) and (11.b) into equation (12.a)

According to the physic conception it must be

$$\tfrac{3}{2}\lambda = 1 \qquad i.e., \qquad \lambda = \tfrac{2}{3} \qquad (12.b)$$

By substituting with the value of λ into all equations, the project of the vector $\hat{I}_{m_1}$ on the axis of the phase x equals the project of the corresponding parts into the same axis.

By substituting with the value of $\lambda = \frac{2}{3}$ equation (12.b) in the equation (9.a) and (9.b) we obtain

$$I_{m_1}\cos(\tau + \phi) = I_{md_1}\cos\phi - I_{mq_1}\sin\phi$$
$$I_{m_1}\cos(\tau + \phi) = I_{m_1}\cos(wt - \phi_1 - \phi)\cos\phi - I_{m_1}\sin(wt - \phi_1 - \phi)\sin$$
$$= I_{m_1}\cos(wt - \phi_1 - \phi)\cos\phi - \sin(wt - \phi_1 - \phi)\sin\phi$$
$$= I_{m_1}\cos(wt - \phi_1) = I_{x_1}$$

$$I_{mq_1} = I_{m_1}\lambda[\cos(wt-\phi_1)\sin\phi + \cos(wt-\tfrac{2}{3}\pi-\phi_1)\sin(\phi-\tfrac{2}{3}\pi) + \cos(wt+\tfrac{2}{3}\pi-\phi_1)\sin(\phi+\tfrac{2}{3}\pi)] \quad (8\text{-}c)$$

$$I_{mq_2} = I_{m_2}\lambda[\cos(wt-\phi_2)\sin\phi + \cos(wt+\tfrac{2}{3}\pi-\phi_2)\sin(\phi-\tfrac{2}{3}\pi) + \cos(wt-\tfrac{2}{3}\pi-\phi_2)\sin(\phi+\tfrac{2}{3}\pi) \quad (8\text{-}d)$$

The expressions in brackets are:

$$\cos(wt-\phi_1)\cos\phi + \cos(wt-\tfrac{2}{3}\pi-\phi_1)\cos(\phi-\tfrac{2}{3}\pi) + \cos(wt+\tfrac{2}{3}\pi-\phi_1)\cos(\phi+\tfrac{2}{3}\pi) =$$

$$= \underline{\tfrac{3}{2}\cos(wt-\phi_1-\phi)}$$

$$\cos(wt-\phi_2)\cos\phi + \cos(wt+\tfrac{2}{3}\pi-\phi_2)\cos(\phi-\tfrac{2}{3}\pi) + \cos(wt-\tfrac{2}{3}\pi-\phi_2)\cos(\phi+\tfrac{2}{3}\pi) =$$

$$= \underline{\tfrac{3}{2}\cos(wt-\phi_2+\phi)}$$

$$\sin\phi\cos(wt-\phi_1) + \sin(\phi-\tfrac{2}{3}\pi)\cos(wt-\tfrac{2}{3}\pi-\phi_1) + \sin(\phi+\tfrac{2}{3}\pi)\cos(wt+\tfrac{2}{3}\pi-\phi_1) =$$

$$= \underline{-\tfrac{3}{2}\sin(wt-\phi_1-\phi)}$$

$$\cos(wt-\phi_2)\sin\phi + \cos(wt+\tfrac{2}{3}\pi+\phi_2)\sin(\phi-\tfrac{2}{3}\pi) + \cos(wt-\tfrac{2}{3}\pi-\phi_2)\sin(\phi+\tfrac{2}{3}\pi) =$$

$$= \underline{\tfrac{3}{2}\sin(wt-\phi_2+\phi)}$$

After substitution in the equation 8-a, 8-b, 8-c, and 8-d we get:

$$I_{md_1} = \tfrac{3}{2}\lambda I_{m_1}\cos(wt-\phi_1-\phi) \quad (9.a)$$

$$I_{md_2} = \tfrac{3}{2}\lambda I_{m_2}\cos(wt-\phi_2+\phi) \quad (9.b)$$

$$I_{mq_1} = \tfrac{3}{2}\lambda I_{m_1}\sin(wt-\phi_1-\phi) \quad (9.c)$$

$$I_{mq_2} = \tfrac{3}{2}\lambda I_{m_2}\sin(wt-\phi_2-\phi) \quad (9.d)$$

Revalution, which corresponds to the synchronous velocity of rotor, are fixed by equation,

$$\phi = (wt+\phi_0) \quad (10)$$

Where ϕ_0 is the value of the phase angle ϕ at time $(t=0)$

$$I_{md} = I_{md_1} + I_{md_2} \quad (6.a)$$
$$I_{mq} = I_{mq_1} + I_{mq_2} \quad (6.\ )$$

For the currents of the direct and inverse systems we can write momentary values.

$$I_{x_1} = I_{m_1} \cos(\omega t - \phi_1) \quad (7.a)$$
$$I_{x_2} = I_{m_2} \cos(\omega t - \phi_2) \quad (7.b)$$

where

I_{m_1} an amplitude current direct system.

I_{m_2} an amplitude current inverse system.

ϕ_1 and ϕ_2 are the phase angles of current at the time ($t = o$)

ω the angular velocity

Similery we can write the components of currents in phases y and z

$$I_{y_1} = I_{m_1} \cos(\omega t - \tfrac{2}{3}\pi - \phi_1) \quad (7.c)$$
$$I_{y_2} = I_{m_2} \cos(\omega t + \tfrac{2}{3}\pi - \phi_2) \quad (7.d)$$

$$I_{z_1} = I_{m_1} \cos(\omega t + \tfrac{2}{3}\pi - \phi_1) \quad (7.e)$$
$$I_{z_2} = I_{m_2} \cos(\omega t - \tfrac{2}{3}\pi - \phi_2) \quad (7.f)$$

By substituting in equation (4 and 5) with the expressions (7) we obtain :

$$I_{md_1} = I_{m_1} \lambda [\cos(\omega t - \phi_1)\cos\phi + \cos(\omega t - \tfrac{2}{3}\pi - \phi_1)\cos(\phi - \tfrac{2}{3}\pi) + \cos(\omega t + \tfrac{2}{3}\pi - \phi_1)\cos(\phi + \tfrac{2}{3}\pi) \quad (8.a)$$

$$I_{md_2} = I_{m_1} \lambda [\cos(\omega t - \phi_2)\cos\phi + \cos(\omega t + \tfrac{2}{3}\pi - \phi_2)\cos(\phi - \tfrac{2}{3}\pi) + \cos(\omega t - \tfrac{2}{3}\pi - \phi_2)\cos(\phi + \tfrac{2}{3}\pi) \quad (8.b)$$

$$I_{md} = \lambda[(I_{X_1}+I_{X_2}+I_{X_0})\cos\phi+(I_{Y_1}+I_{Y_2}+I_{Y_0})\cos(\phi-\tfrac{2}{3}\pi)+ (I_{Z_1}+I_{Z_2}+I_{Z_0})\cos(\phi+\tfrac{2}{3}\pi)]$$

$$= \lambda[I_{X_1}\cos\phi+I_{Y_1}\cos(\phi-\tfrac{2}{3}\pi)+I_{Z_1}\cos(\phi+\tfrac{2}{3}\pi)]+ \lambda[I_{X_2}\cos\phi+I_{Y_2}\cos(\phi-\tfrac{2}{3}\pi)+I_{Z_2}\cos(\phi+\tfrac{2}{3}\pi)]+ \lambda[I_{X_0}\cos\phi+I_{Y_0}\cos(\phi-\tfrac{2}{3}\pi)+I_{Z_0}\cos(\phi+\tfrac{2}{3}\pi)].$$

There we can write :

$$I_{md_1} = \lambda[I_{X_1}\cos\phi+I_{Y_1}\cos(\phi-\tfrac{2}{3}\pi)+I_{Z_1}\cos(\phi+\tfrac{2}{3}\pi)] \quad (4.a)$$

$$I_{md_2} = \lambda[I_{X_2}\cos\phi+I_{Y_2}\cos(\phi-\tfrac{2}{3}\pi)+I_{Z_2}\cos(\phi+\tfrac{2}{3}\pi)] \quad (4.b)$$

$$I_{md_0} = \lambda\,.\,I_{X_0}[\cos\phi+\cos(\phi-\tfrac{2}{3}\pi)+\cos(\phi+\tfrac{2}{3}\pi)] \quad (4.c)$$

The brackets in equation (4.c) will be.

$$\cos\phi+(\cos\phi\cos\tfrac{2}{3}\pi+\sin\phi\sin\tfrac{2}{3}\pi)+(\cos\phi\cos\tfrac{2}{3}\pi- \sin\phi\sin\tfrac{2}{3}\pi)$$

$$= \cos\phi+2\cos\phi\cos\tfrac{2}{3}\pi = 0 .$$

Therefore $I_{md_0} = 0$

Similary for I_{mq} *:*

$$I_{mq_1} = \lambda[I_{X_1}\sin\phi+I_{Y_1}\sin(\phi-\tfrac{2}{3}\pi)+I_{Z_1}\sin(\phi+\tfrac{2}{3}\pi)] \quad (5.a)$$

$$I_{mq_2} = \lambda[I_{X_2}\sin\phi+I_{Y_2}\sin(\phi-\tfrac{2}{3}\pi)+I_{Z_2}\sin(\phi+\tfrac{2}{3}\pi)] \quad (5.b)$$

$$I_{mq_0} = 0$$

Result :-

The current in the longitudinal and transversal axis consists only of two symmetrical components.

2 — Electromotive Forces (E.M.F.) and fluxes, which correspond with E.M.F., have the same axis.

3 — We can use the method of superposition.

4 — As a positive direction of the phase we use the direction from the end of phase to the beginning of it.

5 — Electromotive Forces, which are excited by positive currents, are positive.

6 — Positive direction of the rotor as a clockwise direction.

7 — The positive direction of axis is in the same position way of M.M.F. in an Field winding.

8 — The longitudinal and the transversal axes make the angle of 90° (electrical degrees).

9) Suppose we examine at the beginning some quantities which are not being zero.

10) The fundamental alternating quantities are in a stablisid situation, sine function of the first harmonic.

11) The stator of synchronous machine is quite symmetrical.

b) THE DEDUCING RELATION FOR THE CURRENT QUANTITIES.

At general loading of the stator the positive momentary values of current vectors are pictured on phase axes X.Y.Z.

We presuppose these momentary values are Ia, Ib, Ic.

In arbitrary moment the values of current phases of the stator are Ix, Iy, Iz.

These currents make in the longitudinal and transversal the summary M.M.F. in the air — gap.

We need to know the currents in axis d and q which will make the same M.M.F. It is necessary that these ingredients must be proportional to summary projective currents on the axis.

Their compoments, respectively on longitudinal transversal axis will be.

$$\left.\begin{aligned} Ixd &= Ix \cos\phi \\ Iyd &= Iy \cos(\phi - \tfrac{2}{3}\pi) \\ Izd &= Iz \cos(\phi + \tfrac{2}{3}\pi) \end{aligned}\right\} (1.a)$$

$$\left.\begin{aligned} Ixq &= Ix \sin\phi \\ Iyq &= Iy \sin(\phi - \tfrac{2}{3}\pi) \\ Izq &= Iz \sin(\phi + \tfrac{2}{3}\pi) \end{aligned}\right\} (1.b)$$

Where ϕ is the angle between positive ayis d and positive axis of phase x.

The summary of these projectives multiplied with real numbe, λ we shall mark Imd, Imq.

The values of λ will be known after relation.

$$Imd = \lambda\,(Ixd + Iyd + Izd)$$

$$Imq = \lambda\,(Ixq + Iyq + Izq)$$

With the equations (1.a) and (1.b) the value of Imd and Imq will be.

$$Imd = \lambda(Ix \cos\phi + Iy \cos(\phi - \tfrac{2}{3}\pi) + Iz \cos(\phi + \tfrac{2}{3}\pi) \quad (2.a)$$

$$Imq = \lambda\,(Ix \sin\phi + Iy \sin(\phi - \tfrac{2}{3}\pi) + Iz \sin(\phi + \tfrac{2}{3}\pi)) \quad (2.b)$$

For unsymmetrical phenomena we shall use the symmetrical components. Every vector must be devided into vectors of three systems :-

1) Direct system (with mark 1)
2) Inverse system (with mark 2)
3) Zero system (with mark 0)

The values of the phase currents in terms of the symmetrical components are:

$$\left.\begin{aligned} Ix &= Ix_1 + Ix_2 + Ix_0 \\ Iy &= Iy_1 + Iy_2 + Iy_0 \\ Iz &= Iz_1 + Iz_2 + Iz_0 \end{aligned}\right\} \ldots (3)$$

Where :

$$Ix_0 = Iy_0 = Iz_0$$

By substitating with these relations into the equations (2.a) and (2.b) we get:

ANALSIS OF STATIC STABILITY OF SYNCHARONOUS MACHINE

BY

Dr. ABDEL FATTAH HOAWAD*

CONTENTS

ANALYSIS OF TRANEIENTS IN ELECTRICAL SYSTEMS WITH DEVIDED PARAMETERS

We shall take into consideration a simple scheme with:

a) One - Sided afferent of electrical scheme energy.

b) Two - Sided afferent of electrical scheme energy.

This work needs aquaintance with transient process in a synchronous machine, in a transformer and on the line.

For desription of these precess in a synchronous machine, we shall use the theory of two reactances. This theory is united in the U.S.A. before all, with names Park, Doherty and Rabertson. And Gorev U.S.S.R.

For description of the processes on the lines, we shall use the knowledge for supplementary four - poled circuit. The mathematical analysis of the transients can be done. using the following tools :

a) Fourier's Integral.

b) Laplace's trasformation.

c) Method of characteristics.

d) The complex form of calculations.

However, we shal use the Laplace's integral transformation.

A — FUNDEMENTAL RULES ABOUT QUANTITIES TRANSIENTS IN A SYNCHRONOUS MACHINT BY USING THE TWO REACTANCES THEORY

a) PRESUPPOSITIONS AND SIMPLIFICATIONS.

For the following deduce, we have to accept the fixed presuppesitions, only some of these are exactly identical with truth. They are :

1 — The open - circuit chracteristic is a straight line (Here we neglect the saturation in iron).

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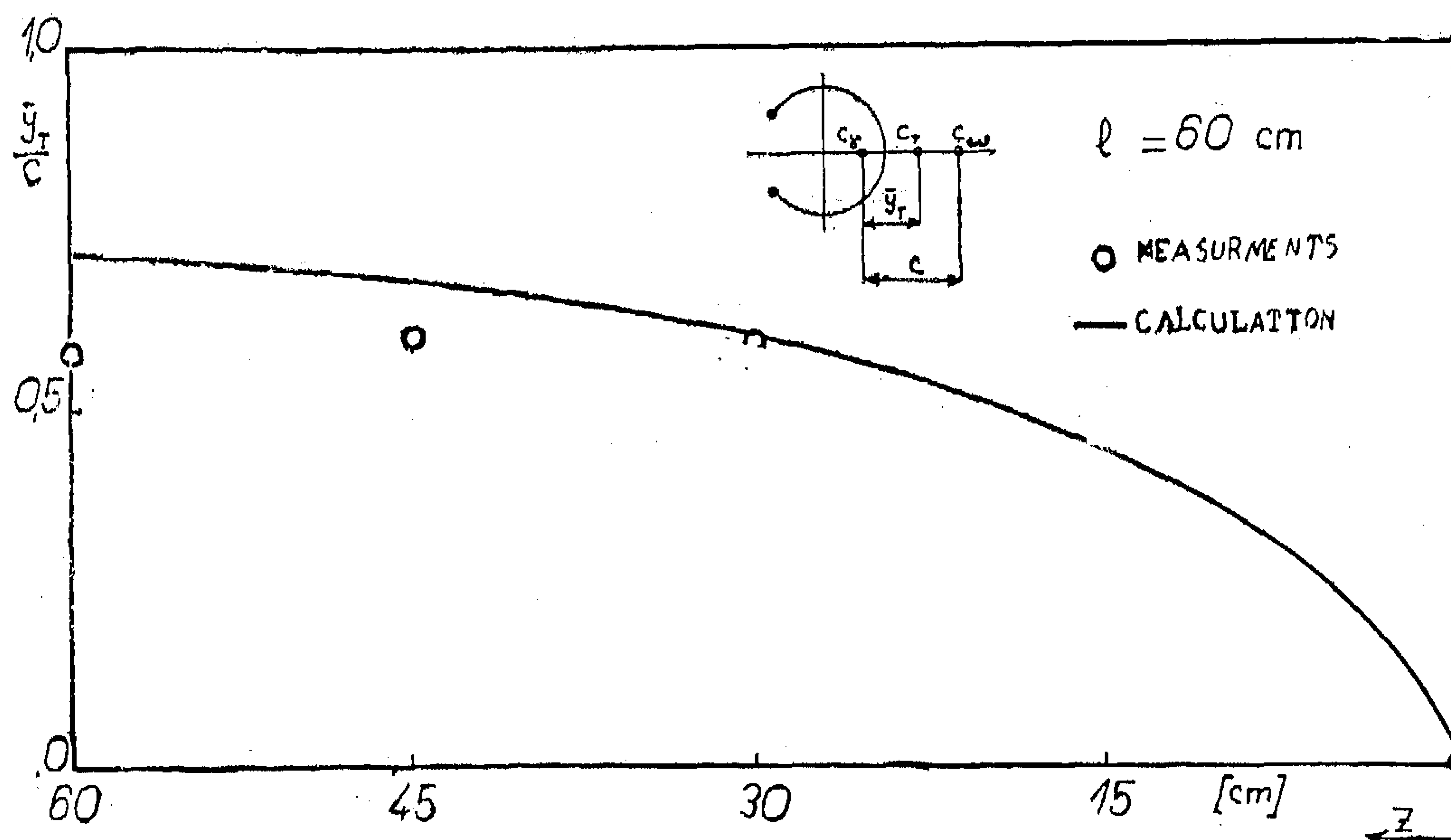


Fig. 7. The twist axis of model, when t_c = 60 cm

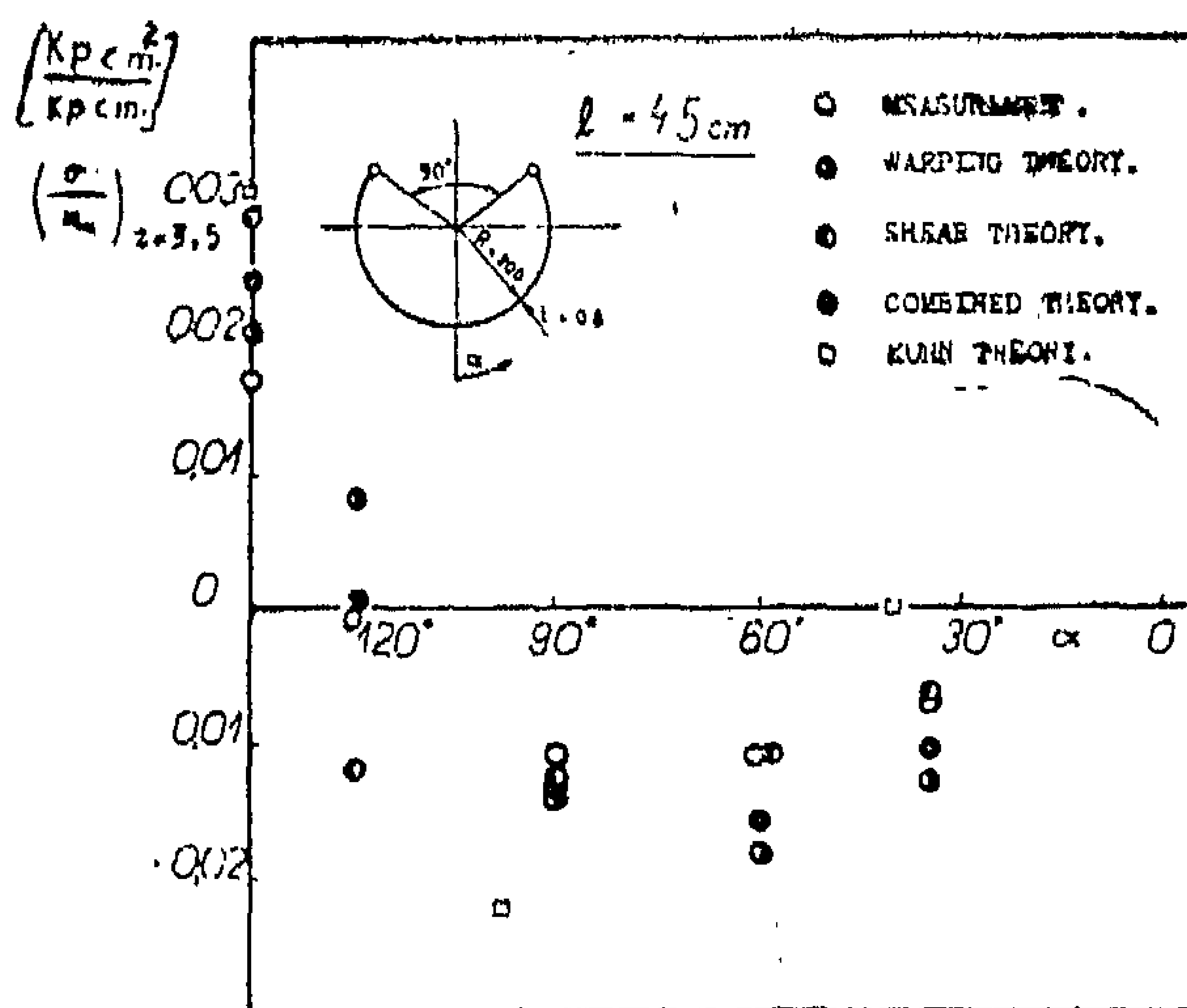
of maximum stresses in built-in end, with respect to the length of the model, fig. 6 is added. Here the importance of the influence of shear theory for relatively shorter beams and warping theory for relatively longer beams is evident.

For the greatest length l = 60 cm of the model there was measured the distribution of deformations to determine the twist axis in several sections of the beam. The measurements for shorter beams could could not be completed because the accuracy of the pick-ups were in the range of measured values.

Both the results of these measurements and calculations according to equation 29, i.e. the position of the twist axis are plotted in diagram fig. 7. The results give generally very good agreement; only on the free end, where the external load is applied, the difference is greater probably due to the load concentration. The other theories, supposing the constant position of twist axis / determined by position (c_w r c_w /, limited the real twist axis. In builin end the twist axis coincides with c_y / "shear theory"/, on the free end, for relatively greater length, the position of twist axis approaches the c_m axis / "warping theory"/.

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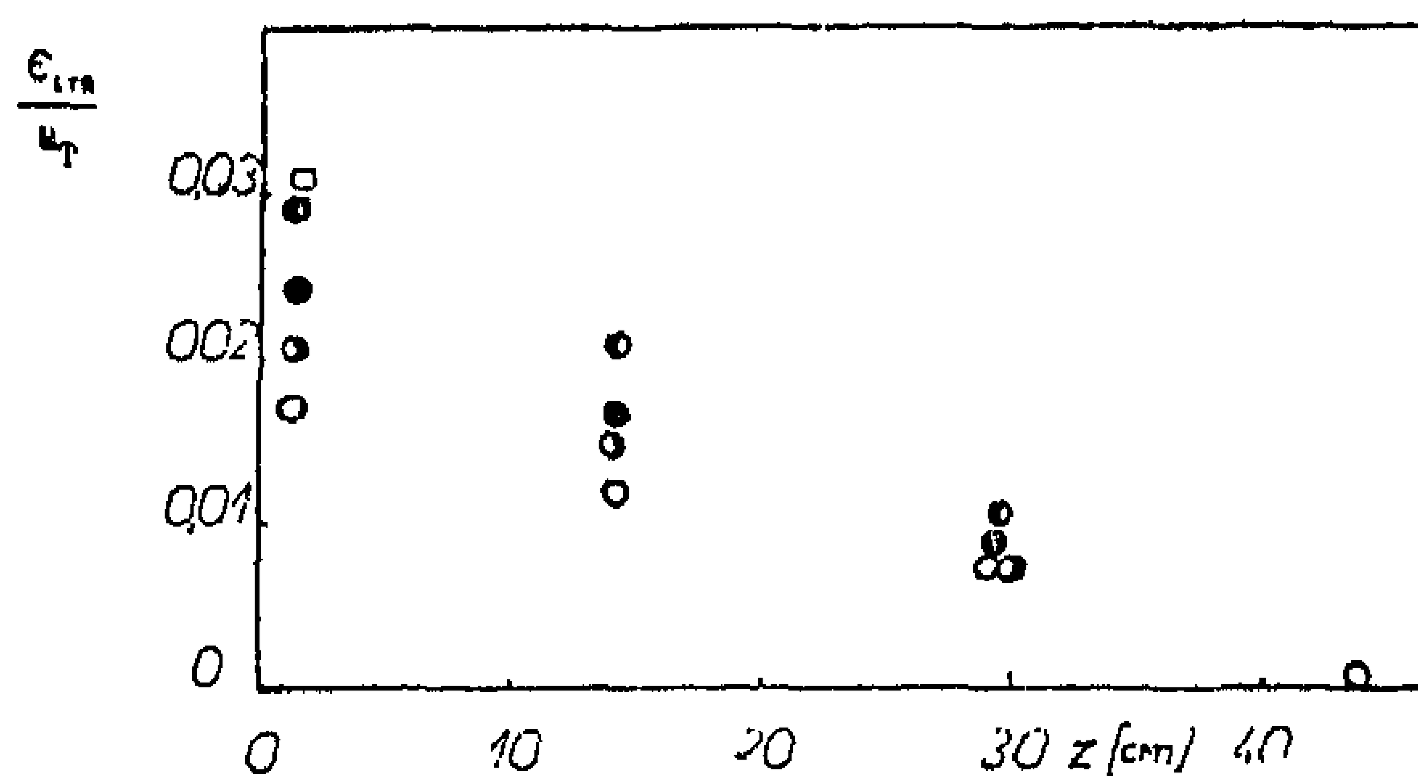


Fig. 5. Typical stress distribution along circumference and in stringer

model according to "warping" and "shear" theories, their combinations, equations 26 and / 6 / in order to compare them with the results taken by the measurements of mentioned model. It is possible to say, that the best approach to the distribution along circumference, comparing with the measurements, is given by the presented theory. This theory is also safe from point of view of maximum stresses in skin and stringer, too. Generally, the smallest difference in distribution of direct stresses is in the stringer when using "warping theory". The importance of "shear theory" is in its application for relatively shorter beams and especially in the vicinity of the built-in end. The distribution of direct stresses along circumference for given model from the plane of symmetry of ments. From the range 90° till the open part there is the best agreement with the theory presented in the article, see fig. 5. The Kuhn theory / 6 /, gives for this kind of structure very safe results in circumferential stress distribution and for stringer stress, too.

To compare the results in distribution

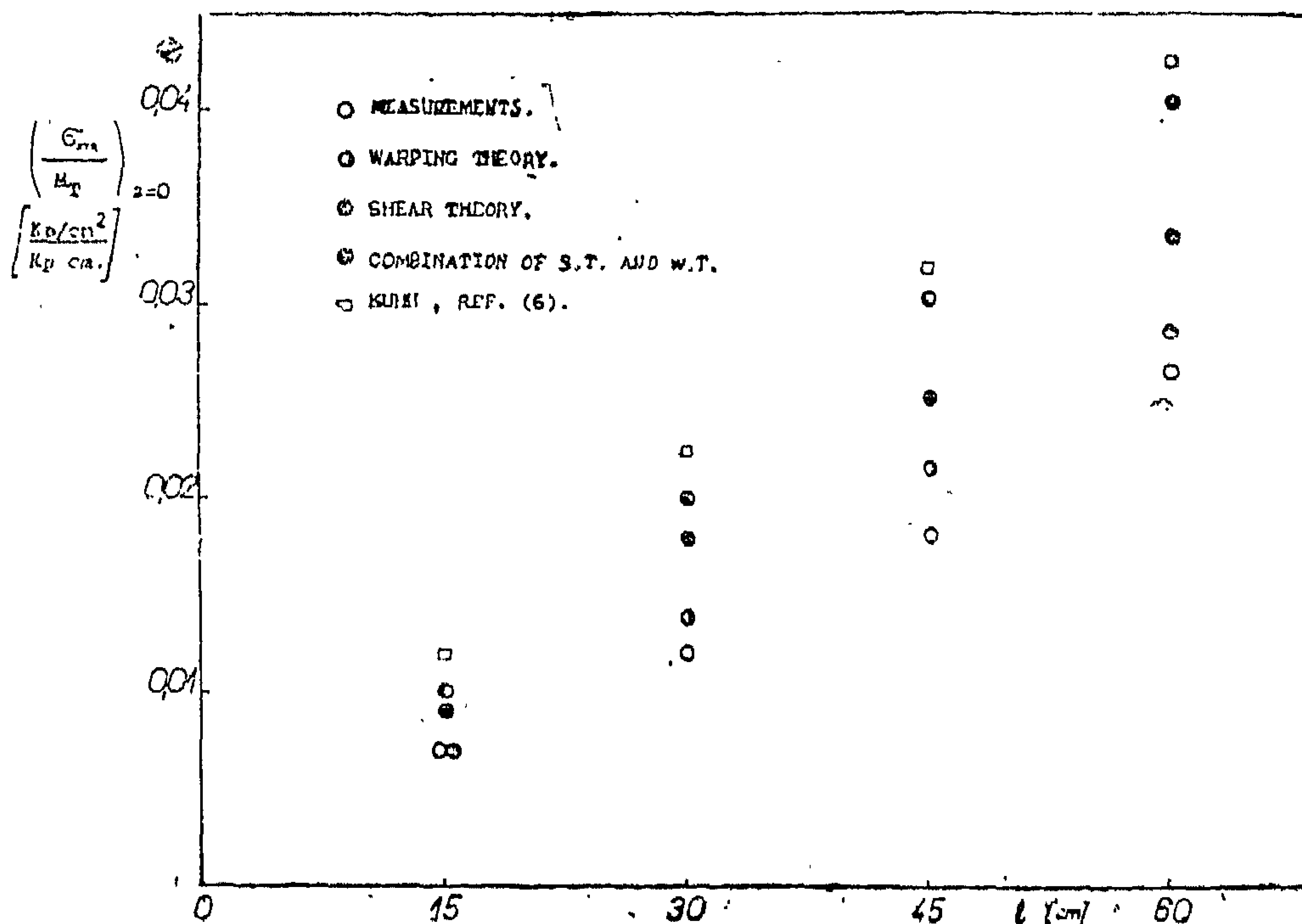


Fig. 6. Maximum values of direct stresses in stringer in built-in section for different length of model

POSITION OF TWIST AXIS

When the external torque M_r is transfered by moments M_w and M_y the twist angles θ_r and θ_w corresponds with them too. The rotations by these angles, are around the centres of bending and twist shear centres C_w and C_y.

According fig. 3, it is possible to determine the coordinate of resultant centre of twist C_t of arbitrary cross section. For it, the following conditions must be fullfilled.

$$\Theta_\gamma (y_T - y_\gamma) = \Theta_\omega (y_\omega - y_T),$$

$$\Theta = \Theta_\omega + \Theta_\gamma \qquad - 27$$

and the coortinace is

$$y_T = \frac{1}{\Theta}\left(\Theta_\omega y_\omega + \Theta_\gamma y_\gamma\right) \qquad - 28$$

When the coordinate of twist centre is measured from C_y, there is

$$\bar{y}_T = \frac{\Theta_\omega}{\Theta_\gamma} C \qquad - 29$$

Te values of rates of Twist are

$$\frac{d\Theta_\omega}{dx} = \frac{M_\omega}{G I_\omega^2} \oint S_\omega^2 \frac{ds}{dt} + \int_0^x \frac{B_\omega}{E I_\omega} dx,$$

$$\frac{d\Theta_\gamma}{dx} = \frac{M_\gamma}{G I_\varphi} + \frac{M_\omega}{G I_\omega^2} \oint S_\omega^2 \frac{ds}{t} + \qquad -30$$

$$+ \int_0^x \left(\frac{B_\omega}{E I_\omega} + \frac{I_\gamma}{E I_\varphi^2} B_\gamma \right) dx$$

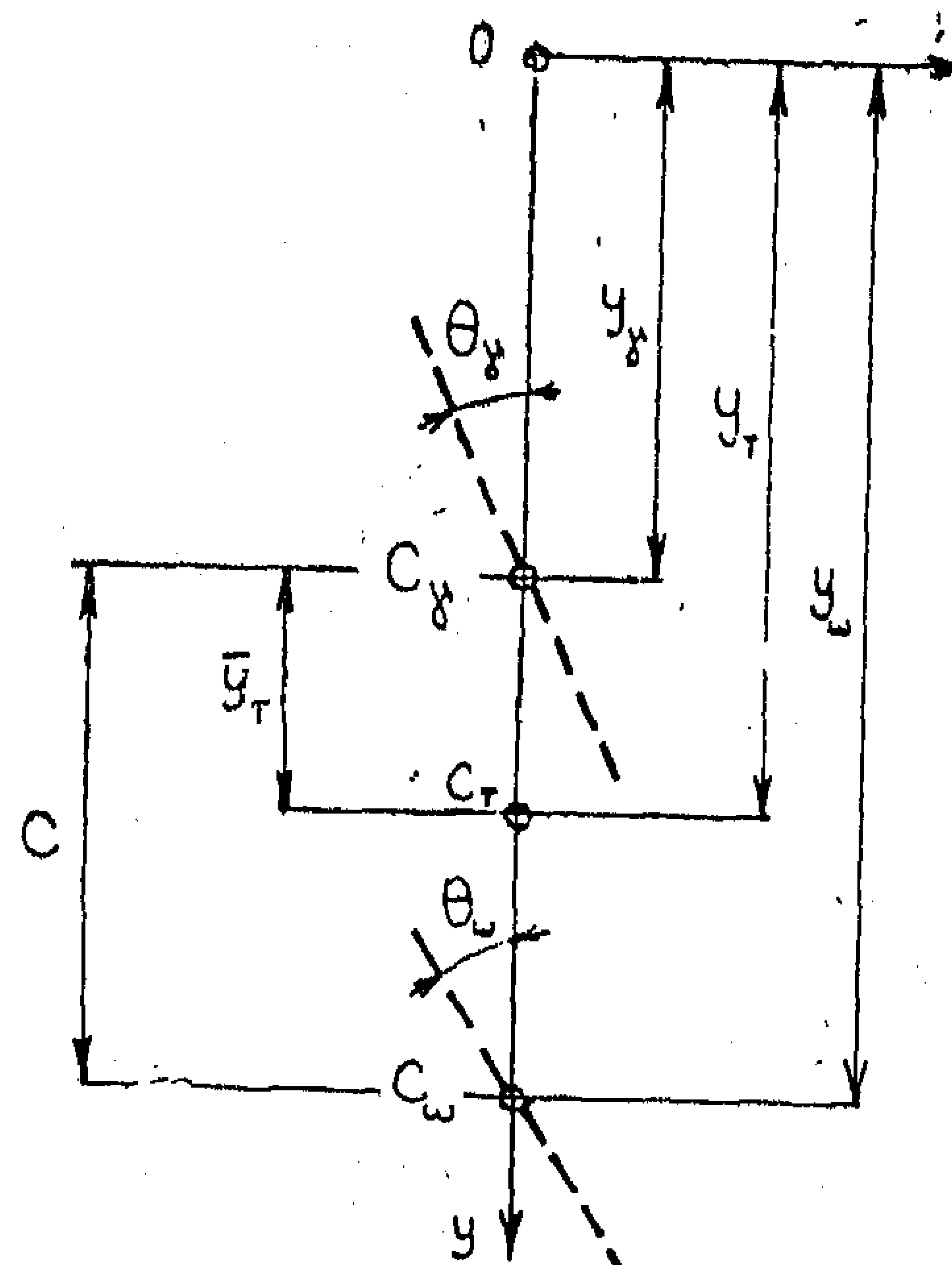


Fig. 3. Determination of position of twist axis

MODEL TESTS

To verify the theoretical results, we have measured, a brass model, fig. 4. The model was the shell with longitudinal stringers along its open part and with system of lateral ribs. As it was necesary to expres also the influence of the length, after complete measurements of one length of model, we have shortened the model by cutting the length corresponding to one pitch of ribs on both sides and measured this shortened model again.

The distribution of direct stresses along the stringers and on the circumference of built-in part, in vicinity of plane of symmetry, was measured by electrical strain gauges. To obtain the position of twist axis, there were also measured the deflections in plane of ribs by inductive pick-ups.

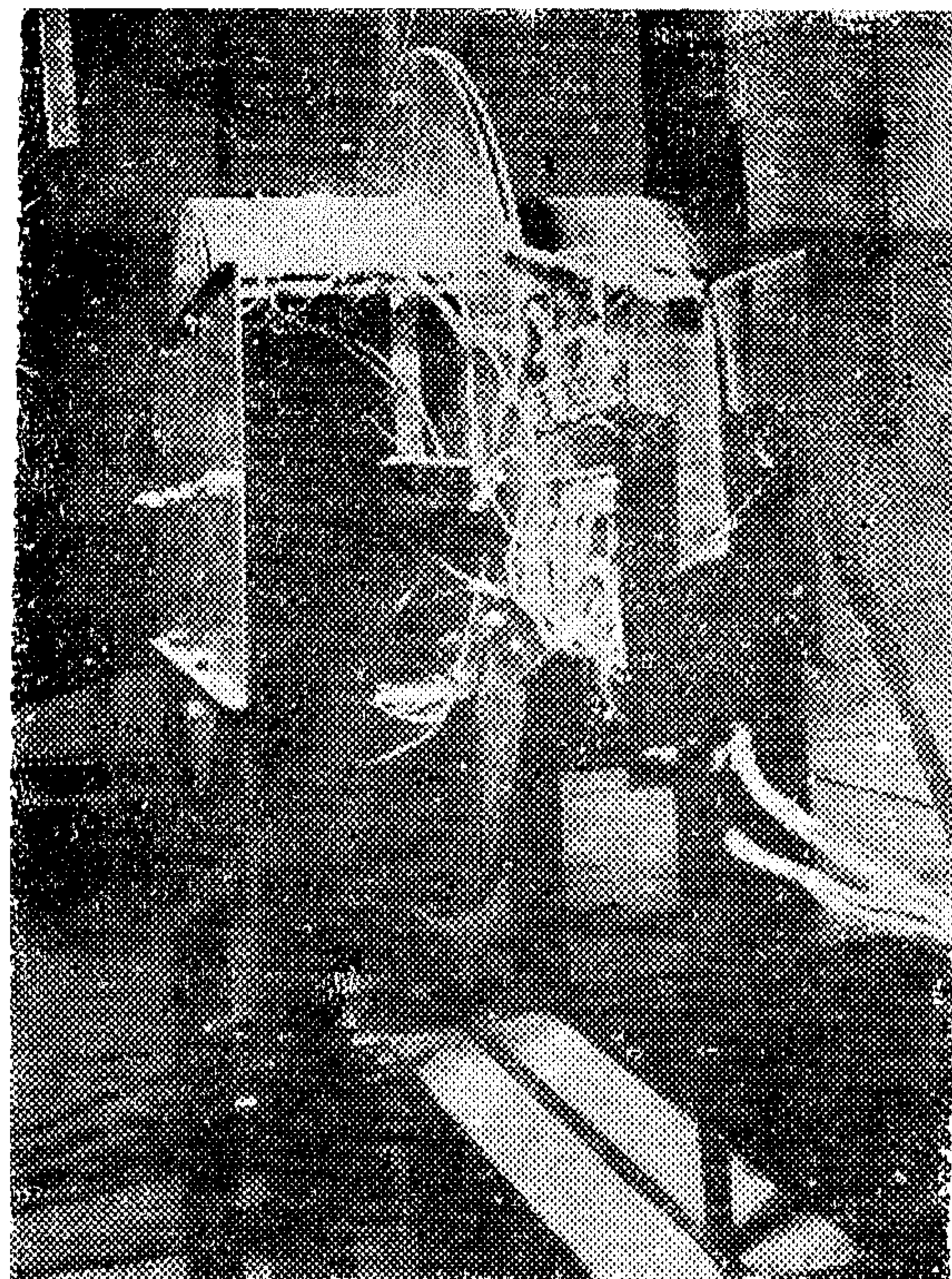


Fig. 4. Arrangement of model test for the shortest length 2 1 = 30 cm.

DISCUSSION OF RESULTS

We have determined the direct stresses and their distribution for the given

where $_y$ is meaured with despect to C_y fig.2.

SOLUTION OF BEAM LOADING

To obtain the distribution of loading along the beam,/ 8,9/, there is a method of variational calculus used in the next part ; the loading is expressed by bimoments B_w , B_y , corresponding moments

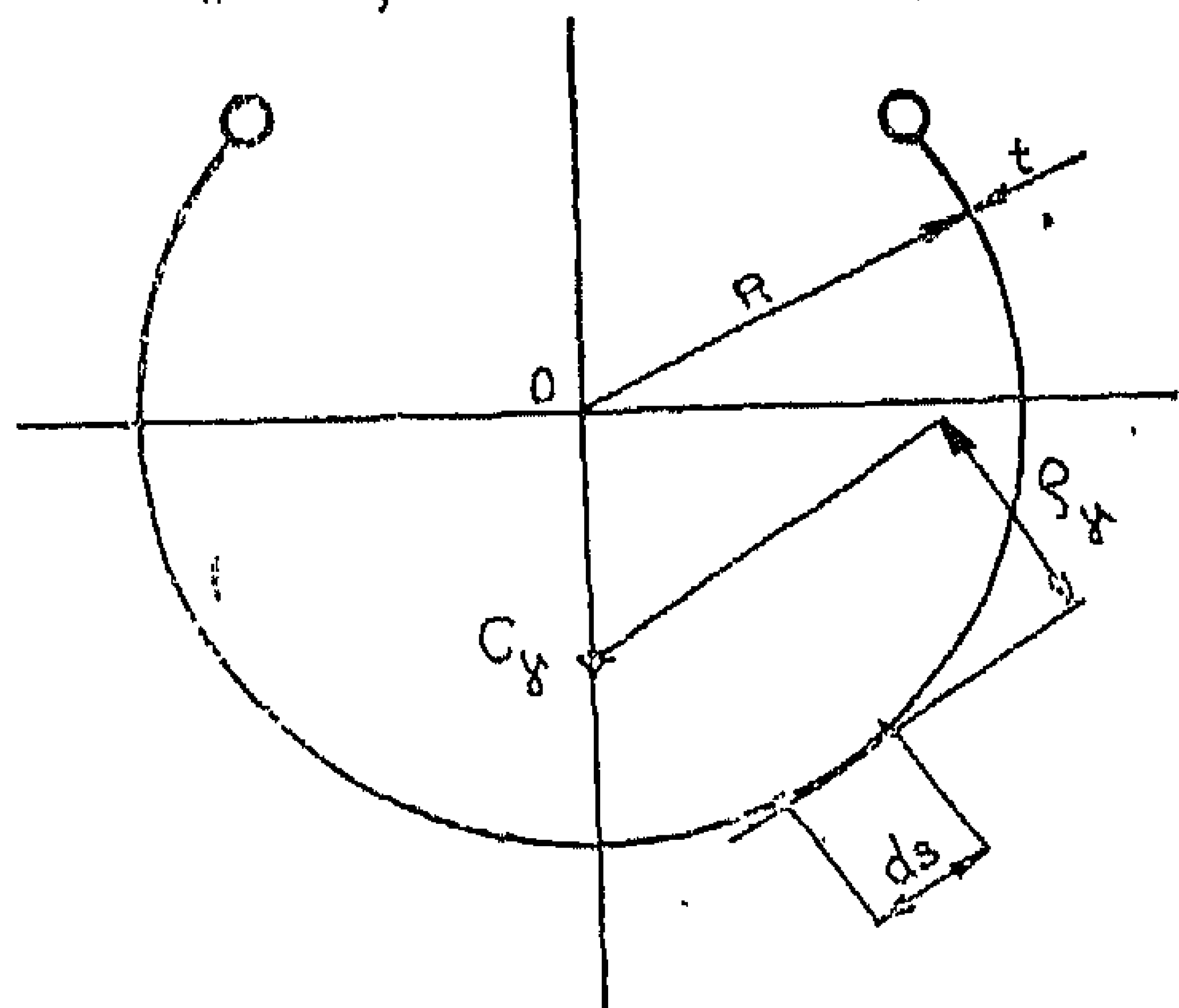


Fig. 2. Main characteristics of "shear theory"

M_{w_I} M_y M_s and Ms. The relations among them are given by

$$\frac{\partial \phi}{\partial B_i} - \frac{d}{dz}\left(\frac{\partial \phi}{\partial \frac{dB_i}{dz}} \right) = 0, \qquad (18)$$

where $\phi = \frac{dn}{dz}$ is the strain energy per unit

$$\Pi = \int_0^{\ell} \phi(x, B_\omega, B'_\omega, B_\gamma, B'_\gamma, M_s)\, dx \qquad -19$$

and

$$\frac{\partial \Pi}{\partial x} = \phi = \oint \frac{\sigma^2}{2E} t\, ds + \int_{-\frac{t}{2}}^{\frac{t}{2}} \oint \frac{\tau^2}{2G}\, ds\, d\bar{t} \qquad -20$$

The values of direct and shear stresses are determined by equations 11 and 16. To complete the solution, it is necessary to respect the conditions of equilibrium of moments and bimoments

$$M_T = B'_\omega + B'_\gamma + M_s = \bar{B}' + M_s \;,$$
$$\bar{B} = B_\omega + B_\gamma \qquad -21$$

When equations 11, 16 and 18 are considered, then equation 20 is equal to

$$\phi = \oint \frac{1}{2E}\left(\frac{B_\omega}{I_\omega}\omega + \frac{B_\gamma}{I_\gamma}\gamma\right)^2 t\, ds + \int_{-\frac{t}{2}}^{\frac{t}{2}} \oint \frac{1}{2G}\left(\frac{M_s}{I_s} 2\bar{t} - \frac{M_\omega}{I_\omega t} S_\omega + \frac{M_\gamma}{I_\varphi t} S_\gamma\right)^2 ds\, d\bar{t} \qquad -22$$

After solution of equation 18 for $B_i = B_w$ and $B_i = B_y$, when equation 22 is introduced, there is obtained a system of diferential equations

$$-B''_\omega a_1 + B_\omega a_2 + B''_\gamma a_3 + B_\gamma a_2 = m_T a_4 \;,$$
$$B''_\omega a_3 + B_\omega a_2 - B''_\gamma a_5 + B_\gamma a_6 = m_T a_7 \;. \qquad -23$$

The coefficients in equation 23 are

$$a_1 = \frac{1}{G}\left(\frac{1}{I_s} + \frac{\oint S_\omega t\, ds}{I_\omega I_s} + \frac{\oint S_\omega^2 \frac{ds}{t}}{I_\omega^2}\right),$$

$$a_2 = \frac{1}{E I_\omega},$$

$$a_3 = \frac{1}{G}\left(\frac{\oint S_\gamma t\, ds}{2 I_\varphi I_s} - \frac{\oint S_\omega t\, ds}{2 I_\omega I_s} - \frac{1}{I_\varphi} - \frac{1}{I_s}\right),$$

$$a_4 = -\frac{1}{G}\left(\frac{\oint S_\omega t\, ds}{2 I_\omega I_s} + \frac{1}{I_s}\right), \qquad -24$$

$$a_5 = \frac{1}{G}\left(\frac{1}{I_\varphi} + \frac{1}{I_s} - \frac{\oint S_\gamma t\, ds}{I_\varphi I_s}\right),$$

$$a_6 = \frac{I_\gamma}{E I_\varphi^2}$$

$$a_7 = \frac{1}{G}\left(\frac{\oint S_\gamma t\, ds}{2 I_\varphi I_s} - \frac{1}{I_s}\right),$$

$$I_\gamma = \oint \gamma^2 t\, ds \;, \quad m_T = \frac{dM_T}{dx}$$

There are boundary conditions for the solution of equations 23 and 24 :

— for free end, where z = l, which is not loaded by direct stresses and there is $\sigma = 0$, are $B_w = B_y = 0$

— for built-in end, where z = 0

$$\left.\frac{\partial \phi}{\partial \left(\frac{dB_w}{dz}\right)}\right|_{z=0} = 0,$$

$$\left.\frac{\partial \phi}{\partial \left(\frac{dB_y}{dz}\right)}\right|_{z=0} = 0 \qquad -25$$

If the influence of St. Venant torsion rigidity GI_s can be neglected, common in aircraft structures, the equation 23 can be simplified as follows

$$B''_\omega - \lambda^2 B_\omega = -\lambda^2 \bar{B} \;,$$
$$B''_\gamma - \lambda^2 B_\gamma = m_T \;, \qquad -26$$

Where

$$\lambda^2 = \frac{G}{E}\,\frac{\frac{I_\gamma}{I_\varphi^2} - \frac{1}{I_\omega}}{\frac{1}{I_\omega^2}\oint S_\omega^2 \frac{ds}{t} - \frac{1}{I_\varphi}}$$

A corresponding direct stress is

$$\sigma_w = -(\Theta_w''{}_w - f'(z))\,E \qquad -6$$

It follows from the equilibrium conditions that $F(z) = 0$ when the origin of coordinats S is in O_w; at the same time the condition

$$S_w = \oint w t ds = 0 \qquad -7$$

must be fulfilled.

The shear stress is determined as the secondary one, from condition of equilibrium

$$\frac{\partial \tau_\omega}{\partial s} t\,ds + \frac{\partial \sigma_\omega}{\partial z} t\,ds = 0 \qquad -8$$

and using equation 6 there is

$$\tau_\omega = \frac{E\,\Theta_\omega}{t} S_\omega \qquad -9$$

For simplification of equations 6 and 9 and from the point of view of similarity with Navier bending, it is introduced the term bimoment

$$B_W = \oint \sigma_w \cdot w \cdot dF \qquad 10$$

When equation 10 is used in equations 6 and 9, then

$$\sigma_\omega = \frac{B_\omega}{I_\omega}\omega \;,\; \tau_\omega = -\frac{B'_\omega}{I_\omega t} S_\omega ; \qquad -11$$

$$B'_\omega = \frac{dB_\omega}{dz} = M_\omega \;,\quad I_\omega = \oint \omega^2 dF$$

$I_w = \phi_w^2 . dF$, is the warping constant of secondary bending with respect to the tangential direction to median line of cross section. The influence of secondary bending in normal direction to the median

$I_\nu = \frac{1}{12}\oint \rho_\nu^2 t^3 ds$ Fig. 1, can be added

jo I_w; $I_{,,}$ is small in comparison with I_w and is usually neglected.

SHEAR THEORY

For the stress and deformation analysis of relatively short beams the theory, 5, 7 / is used with good results. This theory is based on the assumption of zero warping of cross section of a loaded beam. Under this assumption, the values of shear stresses and secondary, the corresponding direct stresses are derived. The mentioned assumption of the theory can be expressed by $\frac{\partial W}{\partial S} = 0$. The displacement of the point on median line, when the twist rate is θ_y and when the twist is with respect to "twist shear centre" C_y, fig. 2 is

$$du = \rho_y \frac{\partial \Theta_y}{\partial z} dz \qquad -12$$

A corresponding shear stress is

$$\tau_\gamma = G \rho_\gamma \Theta'_\gamma \qquad -13$$

The direct stress follows from the condition of equilibrium of structure element; when normal load is not applied on the free end of the beam

$$\sigma_y = \int_e^z \frac{G}{t}\,\Theta'_y\,\frac{\partial(\rho_y t)}{\partial s}\,dz \qquad -14$$

Introducing the expression of bimoment as in the previous case,

$$B_y = \int_e^z M_y \, dz \qquad -15$$

the stresses, using equations 13, 14 and 15 are

$$\tau_\gamma = \frac{M_\gamma}{I_\rho t} S_\gamma \;, \qquad -16$$

$$\sigma_\gamma = -\frac{B_\gamma}{I_\rho}\gamma \;,$$

where

$$S_\gamma = \rho_\gamma t = \int_0^s \gamma t\,ds \;,$$

$$I_\rho = \oint \rho_\gamma^2 t\,ds \;,$$

$$\gamma = \frac{1}{t}\frac{\partial(\rho_\gamma t)}{\partial s} \;,$$

The problem was firstly solved by Timoshenko,/1/, when demonstrating the task on I profile under torsion, when one end was built in and the second one, free end loaded by torque moment. The basis idea of his solution is used in many other works. There is a distribution of external load into two moments. One being transfered by St. Venant type and the other by mentioned so called secondary bending. More general solution was given by Wagner,/2/; his kinematic view was developed for soluticn of beams with open and closed cross section by other authors many times/e.g. Vlasov's solution of stability, /3//. One of the solutions was given by Argyris, /4/.

There exist a great number of works of soviet authors like Marjin, /5/, Klimov, Turkin, etc. solving this problem. The works concerned usually some parts of the wide and complicated branches, searching for the influence of length and cross sectional characteristics. In NACA, there was a wide set of tests made by Kuhn,/6/. The results of the values and distributions of direct and shear stresses are given in diagrams.

As there are plenty of characteristics to be concerned in the solution, usually the authors solved some part of the problem only and thus, this question is not completly answered till now.

SURVEY OF BASIC THEORIES

In order to apply the variational calculus, used in the following part, is necessary to determine the strain energy of the beam under the load. In supposed case, there are the St. Venant stress and stresses due to restrained warping discussed according so called "warping theory" and "shear theory".

ST. VENANT TORSION

In thin walled open section beam under torque $M_T = M_s$, the shear stress τ is proportional to the distance t measured from the median line of the wall :

$$\tau = 2 \frac{M_s}{T} t \qquad (1)$$

where I_s is the torsion constant of the cross section in St. Venant torsion.

WARPING THEORY

A restrain of warping, /2,3,4/ results in non-linear rate of the twist distribution along the length of the beam which is accompanied by a system of direct and corresponding to this the shear stresses.

It is assumed that there is no shear stresses in median surface and the cross section doesn't change its form; then

$$\frac{\partial u}{\partial z} + \frac{\partial w}{\partial s} = 0 \qquad (2)$$

where $u = \psi(z,s)$, $w = \varphi(z,s)$ are the displacements of point of median surface in tangent and longitudinal directions respectively. The beam cross sections are twisted about bending shear centre c_w and the twist angle is Θ_w fig. 1.

Then

$$\frac{\partial u}{\partial z} = \Theta'_w \varrho_w \qquad — 3$$

and the value of warping from equations 2 and 3 is

$$w = -\Theta'_w \omega + f(z) \qquad - 4$$

Where

$$\omega = \int_0^s \varrho_w \, ds \qquad - 5$$

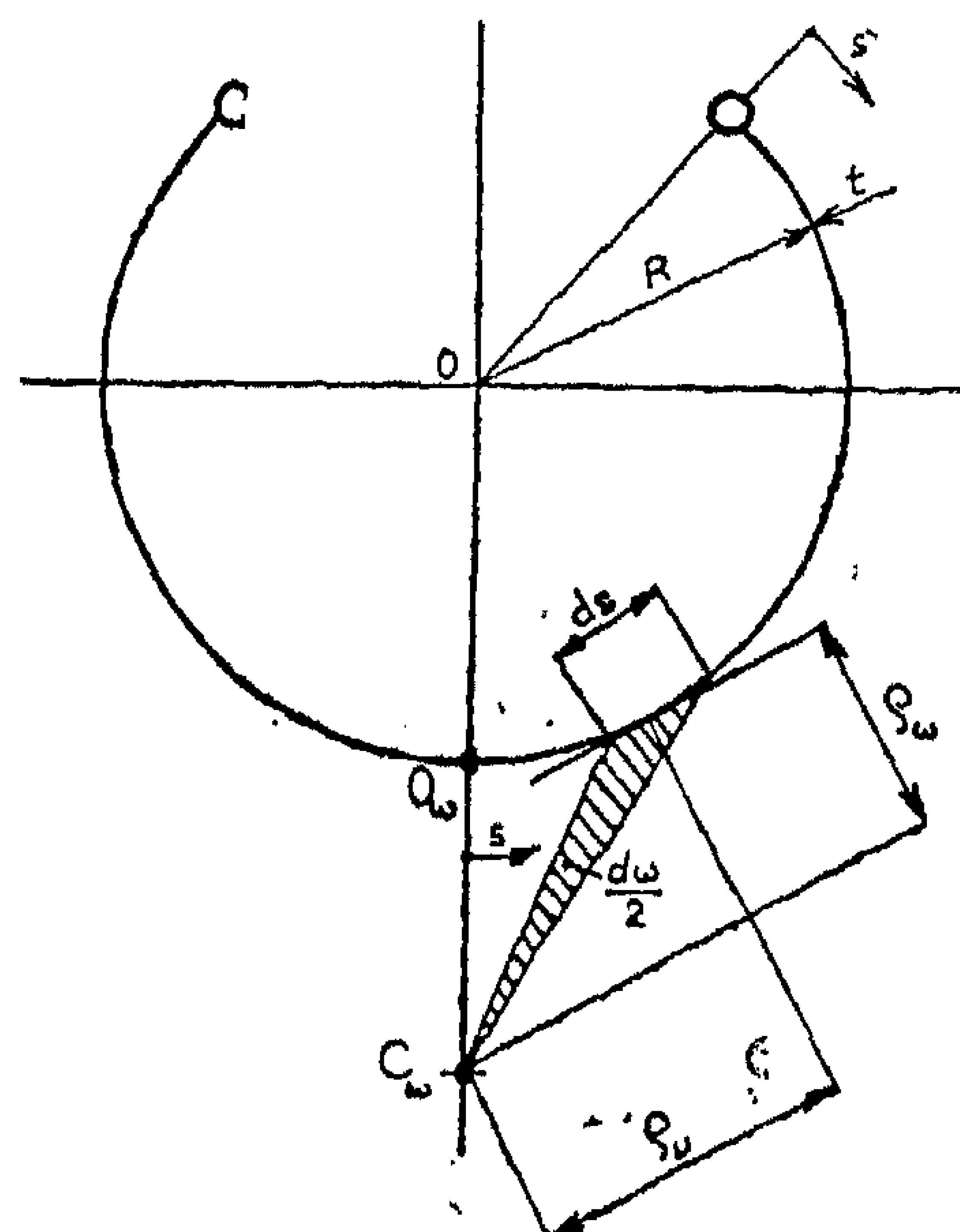


Fig. 1. Main characteristics of "warping theory"

TORSION OF THIN-WALLED BEAM WITH OPEN CROSS SECTION

"CALKOVSKY ANTONIN" + and "MOKHTAR EL NOMROSSY" ++

SUMMARY

This work solves the distribution of stresses and deformations along the thin walled beam with open cross section under torsion. The authors used several methods for determination of stress distribution and search for the position of twist axis.

The results of theories have been compared with measurements on the model with circular open section.

BASIC NOTATION

l — length of the beam
m_T — torque moment per unit length
s — coordinate of medium line
t — thickness of wall
w — warping of medium line point
x,y — coordinates of lateral cross section of the beam
z — coordinate measured in longitudinal direction of the beam; its origin is in built in end section
B — bimoment
E,G — Young's and shear moduli
I — torsion constant
I_ω — warping constant
M — torque
S — characteristic of cross section
γ — coordinate of cross section according to "shear theory"
ω — coordinate of cross section according to "warping theory"
σ, τ — direct and shear stress
Π — total strain energy

$$\Phi = \frac{\partial \Pi}{\partial z}$$

Θ — twist angle

Indeces

T — torsion
S — St. Venant torsion
STR — stringer
γ — shear theory
ω — warping theory

INTRODUCTION

The thin walled beams are used in many branches for transfering of general loads; they are advantageous due to their relatively low weight and this is the reason of their widespread use especially in aviation and lately in machinery as well. Continuous effort to decrease their weight results in the development of methods achieving more accurate results in stresses and deformations distribution, their carrying capacity and stability.

In many cases, there is a necessity to interrupt a structure by cutout for the assembly or function reasons. Then, under special conditions, from view points of stress and deformation analysis, the structure can be divided into closed and open section beams. This work solves the beam with open section under torsion. If there is a free torsion, the open cross section beam transfers the torque by St. Venant shear stress; due to the restrained warping there is an origin of the system of direct and shear stresses, which are variable along the length of the beam, producing so called secondary bending. These changes have the principal character and the determination of their values is the source of series of problems included in the so called "restrained warping".

+ PhD, Military Technical College
++ Engineer, Military Technical College

INDUSTRY & PRODUCTION

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قمة الصناعة العربية المتطورة . تقدمها فيليبس

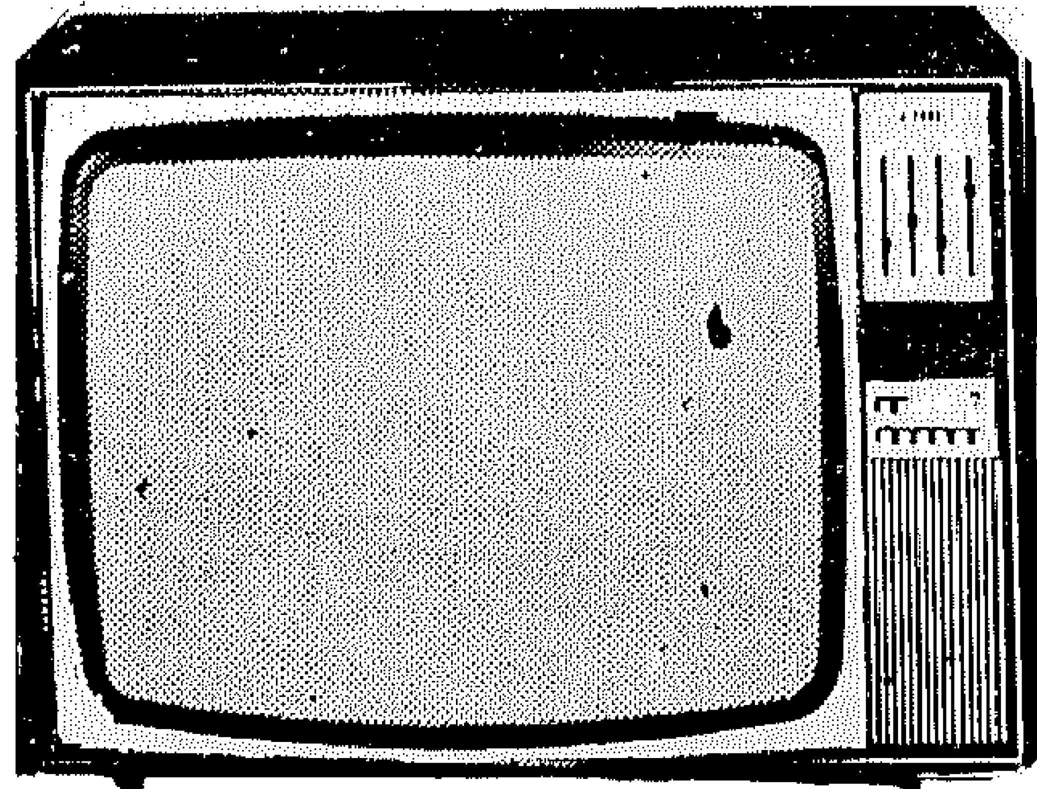


شركة النصر للأجهزة الكهربائية والألكترونية
« فيليبس »

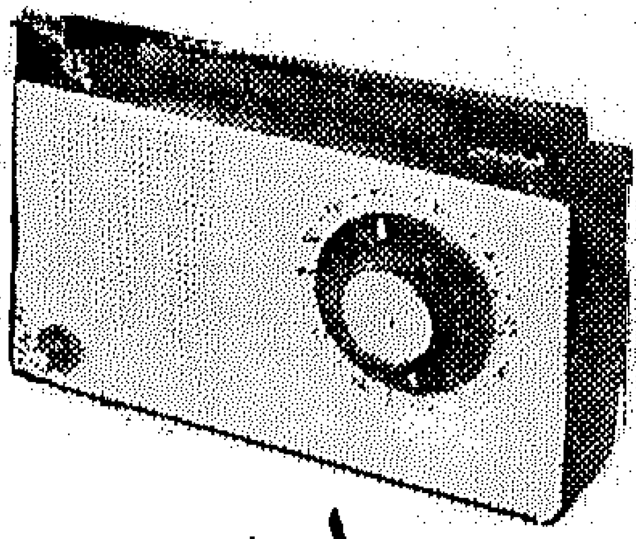
إحدى شركات المؤسسة المصرية العامة للصناعات الهندسية والكهربائية والألكترونية

EL-NASR ELECTRICAL & ELECTRONIC APPARATUS Co. S.A.A,

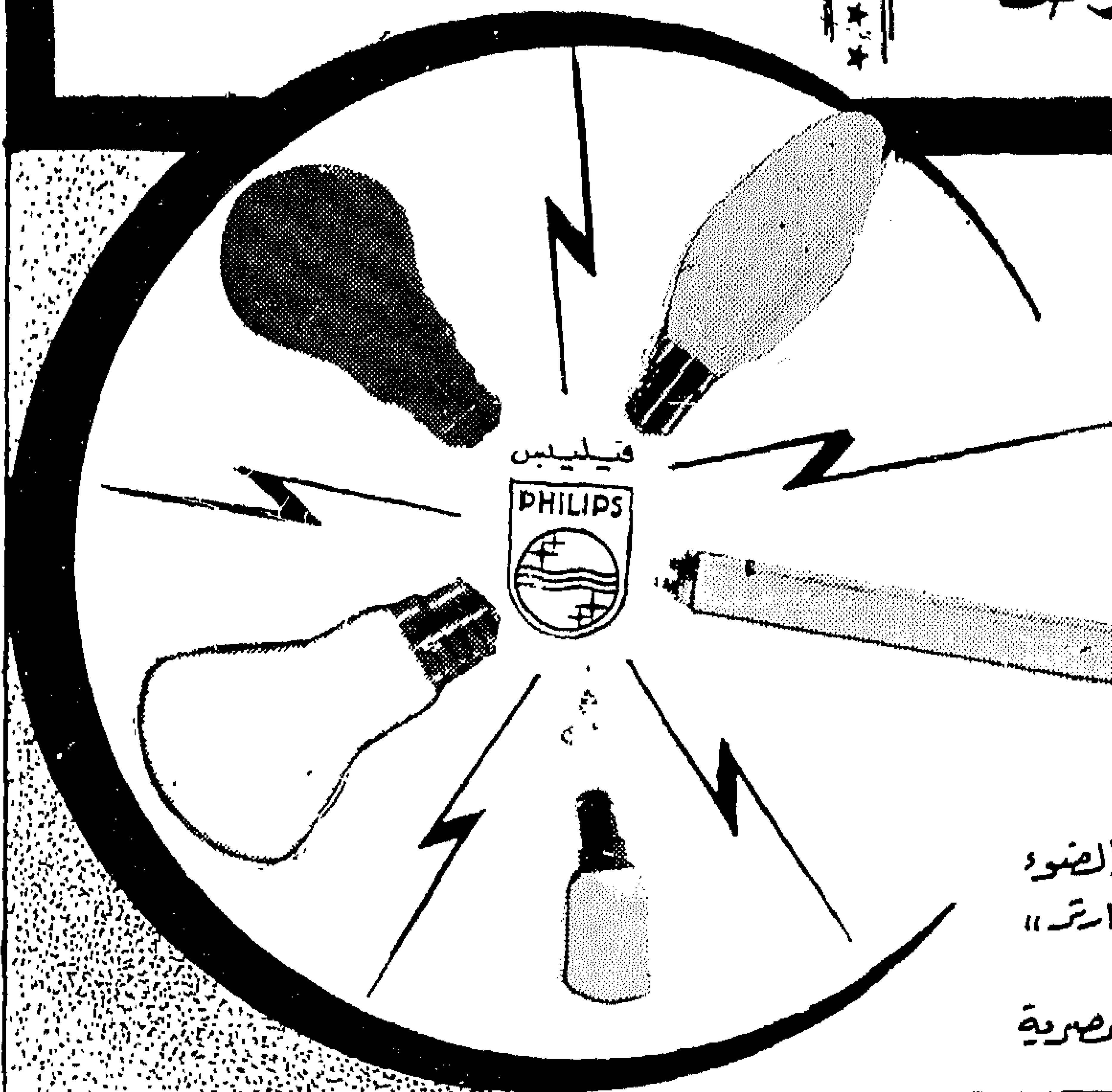
PHILIPS



تليفزيون
فيليبس ٢٤ بوصة



راديو
فيليبس
ترانزستور شنطة



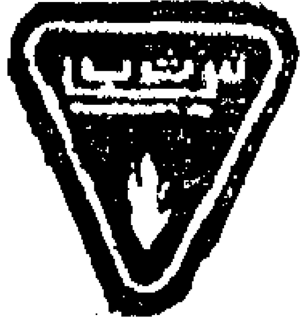
كبرى شركات
إنتاج المصابيح
الكهربائية
فى الشرق الأوسط

مجموعة مختلفة الأشكال
من المصابيح الكهربائية

العادية والفلورسنت والزئبقية والضوء
المختلط وبادىء الإنارة « ستارتر »
للمبات الفلورسنت
تفى بكافة أغراض الإضاءة العصرية

المكاتب والمعارض : ٢٦ شارع عدلى بالقاهرة - كيس بريد القاهرة ت ٤٩٧٤٨-٧٤٦٩٣
فرع الإسكندرية : ٩ شارع سيزوستريس تليفون : ٢٥٧٦٠
مركز الخدمة : ٣١١ شارع شبرا بالقاهرة تليفون : ٩٤٤٥٩٩

العنوان التلغرافى
« فيلور »
القاهرة



شركة السويس لتصنيع البترول

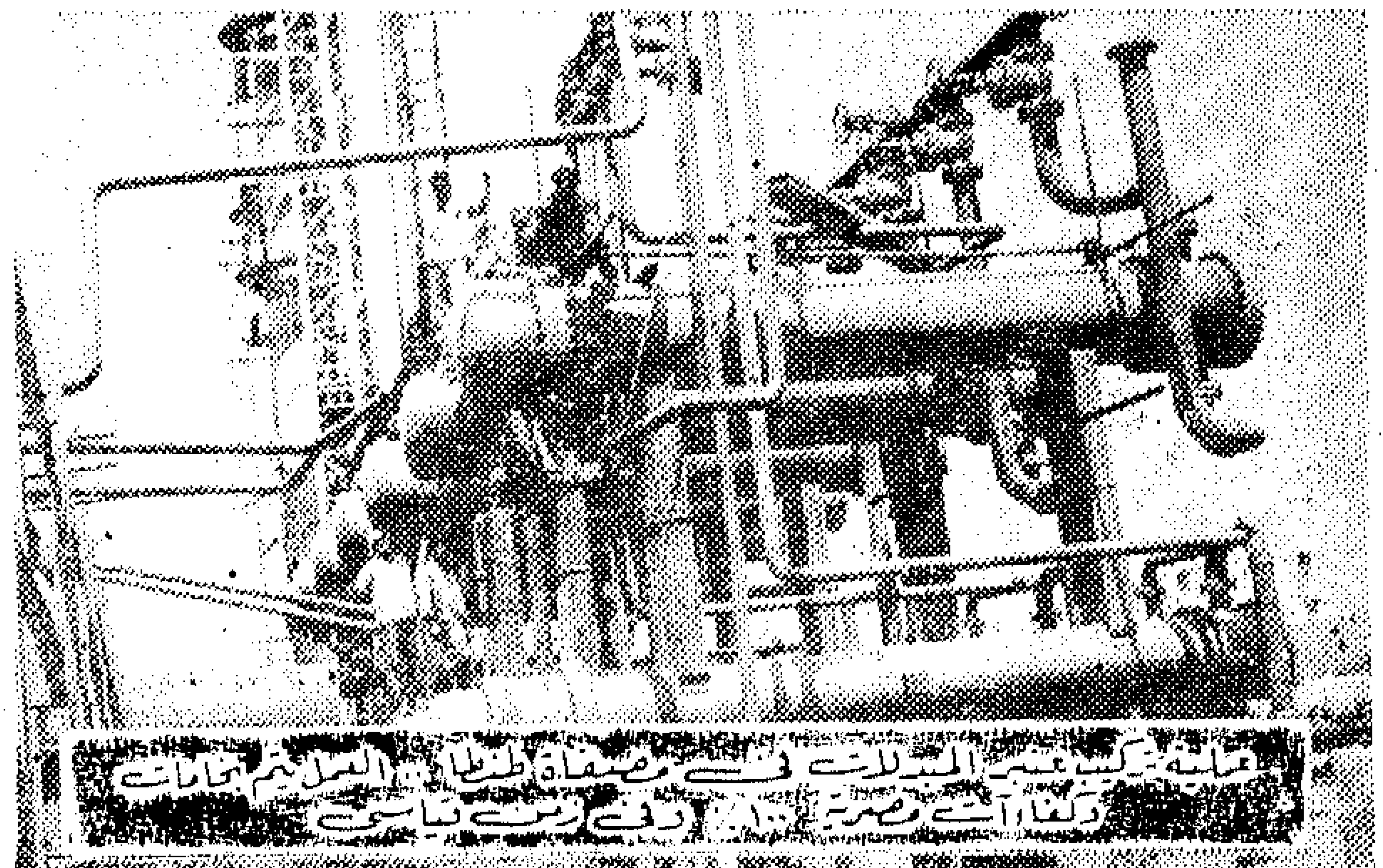
علامة على صناعة البترول فى مصر

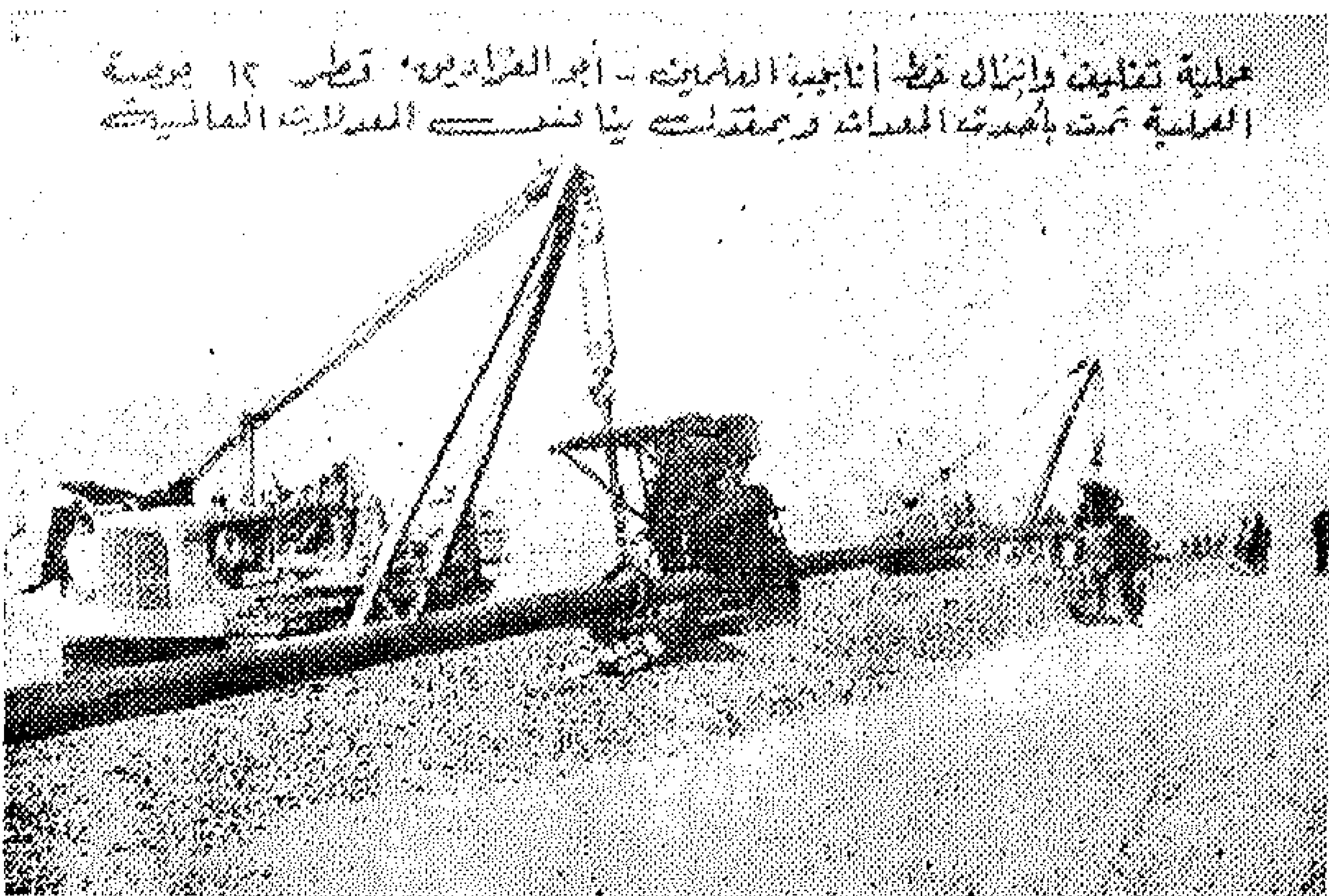
ان الحديث عن شركة السويس لتصنيع البترول باعتبارها اكبر الشركات المصنعة للبترول فى مصر لا يعدو الحقيقة فى شىء وان لم يكن فيه جديد ولكن الجديد الذى يدعو الى الفخر فى نفس الوقت أن تصبح شركة السويس لتصنيع البترول ليس فقط أولى شركات الانشاءات البترولية وانما ايضا واحدة من أكبر شركات الانشاءات بصفة عامة واذا كان هذا يمثل شيئا فانما يمثل تحدى الانسان المصرى المعاصر لقوى البغى والتدمير واصراره على بناء حضارته وتشييد مجده رغم الظروف الصعبة والامكانيات المتواضعة . لقد كان هذا بالضبط هو شعور العامل البسيط الذى دمر له العدو مصنعه فى السويس فاصر على مد شرايين الحياة فى مصر كلها بسائل الحياة فى هذا العصر . فبعد ضرب منشآت الشركة بالسويس تم نقل جهاز تقطير كفاءته ٣٠٠٠ طن فى اليوم الى مسطرد ورفع طاقته الى ٥٧٠٠ طن فى اليوم تم تصميم وانشاء جهاز انتاج الاسفلت الذى يمثل المشروع الثانى للشركة ثم كان المشروع الثالث وهو انشاء وحدة قطف الخام بكفاءة ٥٦٠٠٠ طن/يوم اما المشروع الرابع فهو انجاز صرح جديد لتزويد الدلتا بالمنتجات البترولية وهو مصفاة طنطا وكفاءة المصفاة ٣٠٠٠ طن/يوم ويجرى العمل الان فى تركيب منشآت احدث مشروعات الشركة وهو مشروع اصلاح البنزين المنتج من كافة الاجهزة التكرير بالشركة باستخدام العامل المساعد (Plateninm Catalytic) وهدف هذا المشروع هو رفع الرقم الاوكتينى للبنزين الى ١٠٠ بغرض تصديره الى الخارج اما بالنسبة للمشروعات التى اقامتها الشركة لصالح هيئات وشركات اخرى فقد .

- مدت خطا لنقل الخام من حقول ابو الغراديق ٠ ومقسول الرزاق الى العلمين حجمه ١٢ بوصة وباجمالى طول ١١٠ كيلو متر ثم انشاء شبكة خطوط الابار الخاصة بحقول ابو الغراديق .
- تقوم الشركة حاليا بمد خط انابيب لنقل الخام من البئر رقم ٣٣ المكتشف حديثا الى حقول ابو الغراديق بطول حوالى ٦٠ كيلو مترا وتقوم الشركة ايضا فى هذه الايام بنشاط واسع فى جمهورية ليبيا العربية اكسبها ثقة مؤسسة النفط الليبية فقد قامت بالاتى :

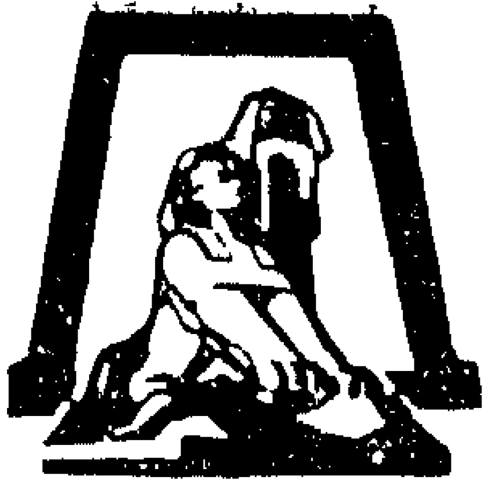
— وضع التصميمات والمواصفات الفنية لمعامل تكرير البترول بالزاوية . وتقوم الان بتصنيع وتركيب شبكات المستودعات فى الزاوية وفى طرابلس بالاضافة الى تركيب عنابر الطلمبات والاشراف الفنى على جميع الاعمال المدنية الخاصة بهذه المستودعات . والتى يبلغ عددها ٣٠ مستودعا .

— وقد خطت الشركة خطوة هامة بهدف التعرف على الخبرات العالمية فى مجال الانشاءات البترولية والاحتكاك بها وذلك بالدخول كشريك مقاول مع شركة منتوبى الايطالية مشروع خط أبو الغراديق ـ العلمين وفى المشروعات التى تقوم بها هذه الشركة لحساب مؤسسة النفط الليبية ولعل أصدق اعتراف بكفاءة شركة السويس ومستوى انتاجها الفنى هو سعى هذه الشركات العالمية للاستعانة بها فى عديد من المشروعات فى الخارج .





وزير الصناعة يتفقد مواقع العمل فى :



مجمع الألومنيوم بنجع حمادى

- يبدأ الانتاج فى العيد الأول لمعركة النصر العظيمة
- صناعة رائدة وحيوية لأول مرة فى مصر
- تسهم فى دعم مظاهر التطور فى كل المجالات

الذى يتابع ما يجرى الآن فى بلدنا فى مجالات الصناعة سوف تأخذه الدهشة .. لأن مصر حققت .. ولا تزال تحقق الكثير فى مجالات الصناعة الهامة .. والتى تعد ركيزة الصناعة فى مصر .

ومنذ بداية الثورة الصناعية فى مصر ، وكان هدفها الأول هو اقامة صناعات على أساس عصرى حديث .

فبدأت فى انشاء مجمع الألونيوم بنجع حمادى الذى يعد طفرة هائلة فى صناعة الألونيوم لأول مرة فى مصر لأنه يحقق ١٤٠ ألف طن قيمتها ٥٦ مليون جنيه بعد تنفيذ التوسعات .. ورصدت له استثمارات تصل ٦٠ مليون جنيه .. ومن المقرر اتمام المرحلة الأولى من هذا المشروع الكبير قبل نهاية العام الحالى وستظهر باكورة انتاجه فى العيد الأول لانتصارنا الكبير فى أكتوبر .. وسينتج ٤٠ ألف طن فى المرحلة الأولى قيمتها ١٦ مليون جنيه حسب الأسعار الحالية تزاد الى ١٠٠ ألف طن عام ١٩٧٥ قيمتها ٤٠ مليون جنيه وفى عام ١٩٧٦ وبعد اتمام التوسعات تصبح الطاقة الانتاجية للمجمع ١٤٠ ألف طن قيمتها ٥٦ مليون جنيه .

ففى الوقت الذى وقف فيه الرئيس المؤمن محمد أنور السادات وخلفه وقفت مصر لتكريم ابنائها أبطال العبور من رجال القوات المسلحة كان المهندس ابراهيم سالم محمدين وزير الصناعة يشارك أبطال الصناعة احتفالهم بزيارته مجمع الألونيوم بنجع حمادى وبصحبته الدكتور طاهر أمين نائب رئيس هيئة التصنيع وكان فى استقبالهما الدكتور يوسف اسماعيل مفوض المجمع والمهندس بهجت حسنين نائب رئيس مجلس ادارة المقاولون العرب .. وجيوش العاملين فى المجمع والمشتركين فى عمليات الانشاء وعمليات التركيب والخبراء السوفيت الذين يتعاونون بصدق واخلاص فى تنفيذ المجمع وقد تم ما يقرب من ٥٠ ٪ من الانشاءات ، ٢٥ ٪ من التركيبات .

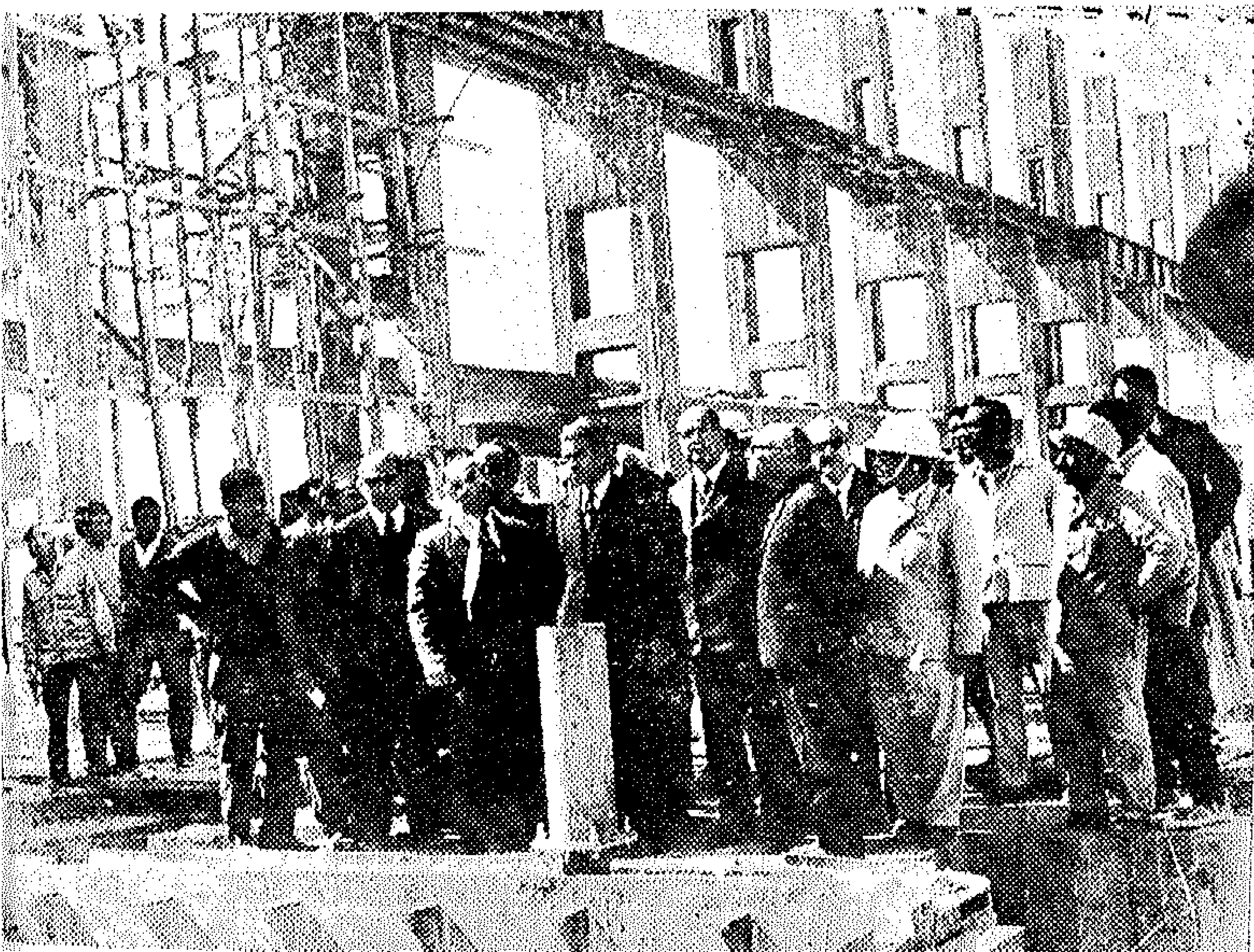
وقد قام الوزير بجولة واسعة تفقد خلالها مختلف الأقسام وفى مقدمتها مبانى الخلايا الانتاجية والمسابك والورش الانتاجية ومركز التدريب والمدينة السكنية والميناء النهرى للمجمع .

وكانت الزيارة التى قام بها الوزير حافزا لمضاعفة الجهد فى المجمع حيث تقرر أن يبدأ الانتاج فى سبتمبر القادم بطاقة انتاجية تبلغ ٤٠ ألف طن بحيث يعمل المجمع الى طاقته الانتاجية الكاملة وهى ١٠٠ ألف طن سنويا فى أوائل العام القادم ...

ولذلك تقرر مضاعفة معدلات التنفيذ فى الانشاءات والتركيبات بحيث يمكن البدء فى جنى ثمار هذا العمل الضخم الذى تبلغ قيمة انتاجه ٤٠ مليون جنيه بالأسعار العالمية الحالية والمتجهة للزيادة .

انجازات ضخمة :

كما كانت زيارة الوزير فرصة لمشاهدة صورة للجهد الكبير الذى يبذل فى اقامة المجمع والانجازات الضخمة التى تحققت . فقد تصادف يوم الزيارة مع مرور عام على بدء العمل فى المنطقة الصناعية .. وفى خلال هذه السنة أمكن تنفيذ نحو ٥٠ فى المائة من أعمال الانشاءات و ٢٥ ٪ من أعمال التركيبات .. وقد أمكن تحقيق هذه النتائج من خلال تنسيق كامل وخطة مدروسة وتنفيذ دقيق .



المهندس ابراهيم سالم محمدين وزير الصناعة والدكتور طاهر أمين نائب رئيس هيئة التصنيع وكبار الزوار يستمعون إلى شرح الدكتور يوسف إسماعيل مفوض المجمع

تنســيق دقيــق :

والمجمع من الناحية الاقتصادية يفتح أمام مصر آفاق المستقبل . لذلك فقد كان من الضرورى أن تتوفر له كل متطلباته فى تنسيق دقيق ومحكم .. وفى اطار هذا التشييد لابد من توفير عدة عناصر :

● أول هذه العناصر هى العمالة .. فان هـــذه الصناعة المتقدمة تحتاج الى عمالة فنية قــد لاتحتاجها الصناعات الأخـرى . ويبلغ عــدد العاملين اللازمين للمجمع ٣ آلاف عامل تبلـغ أجورهم السنوية مليونا و ٧٥٠ ألف جنيه . ولذلك فقد أقيم مركز تدريب خاص بالمجمع لاعداد الفنيين والعمال المهرة وعلى مســتوى الفنيين يتم فى المجمع تدريب ٢٠٠ من خريجى الثانوية الصناعية كل ٦ أشهر .. وعلى مستوى العمال المهرة يتم تدريب ١٠٠ عامل كل شهرين .. وقد تم تخريج الدفعة الثانية من الفنيين فى نهاية يناير الماضى وقبول الدفعة الأولى من العمـــال المهرة من حملة الاعدادية فى فبراير الحالى .. وقد بلغ عـدد العمـال الذين تم تعيينهم حتى الآن ٢٢٠٠ عامل ويتم استكمال العمالة اللازمة قبل نهاية هذا العام .. وقــد تفقد الوزير قاعات المركز وشـــهد عددا من التدريبات والمحاضرات فيه .

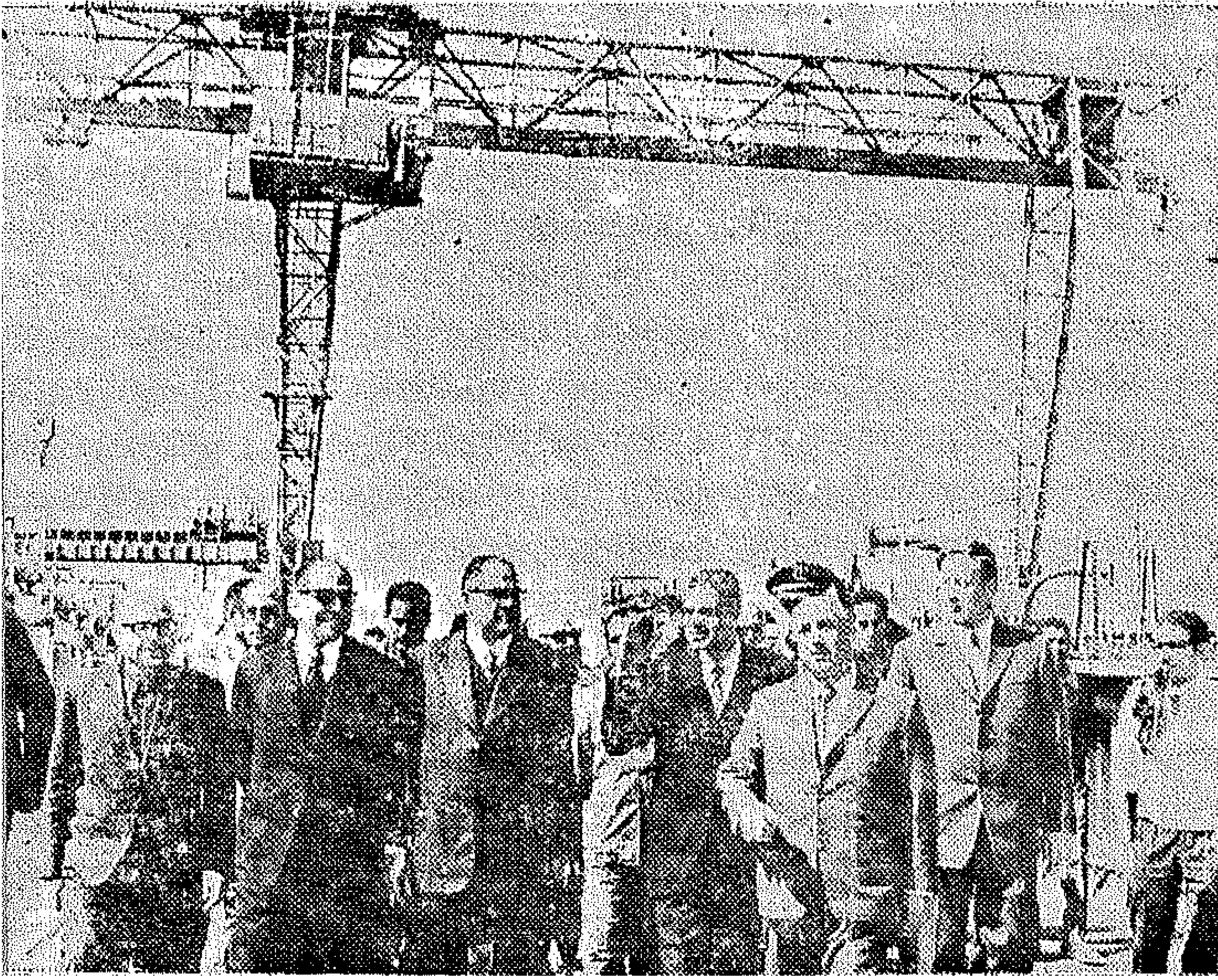
● والعنصر الثانى هو الكهرباء التى لاتستخدم فى الألمونيوم كطاقة فقط ولكنها عنصر أساسى فى الانتاج .. وتبلغ احتياجات المشروع ٢ مليار كيلو وات/ساعة من كهرباء السد العـالى سنويا ، وهذه الاحتياجات قابلة للزيادة .. ولذلك أنشأت محطة محولات خاصة فى منطقة نجع حمادى لتزويد المجمع بالكهرباء .

● والعنصر الثالث هو وسائل النقل .. وفى هذا المجال تم انشاء ميناء نهرى ويجرى انشاء ميناء بحرى خاص فى سفاجا لاستقبال خامات المجمع .. كما تم رصف ٢٠ كيلو مترا من الطـرق الداخلية واجراء تعديلات فى مسار ونهاية خط السكة الحديد بنجع حمادى .

● وفى مجال المياه تم حفر شبكة متكاملة وضخمة من الآبار لتوفير المياه .. كما تم وضع شبكة للصرف الصناعى والصحى تخـدم المنطقـــة الصناعية والمدينـة السـكنية التى تمتد على مساحة ٥٠٠ فدان .

الانســان أولا وأخيرا :

والمدينة السكنية تمثل عنصرا أساسيا فى تخطيط المجمع وفى تنفيذ هـــذا التخطيط ، فان المجمع هو حياة جديدة . فى قلب الصحراء . وفى هذا الموقف كان من الضرورى اقامة المساكن اللازمة للعاملين .. ولذلك فان التخطيط للمدينة السكنية تضم اقامة ٢٠٠٠ وحدة سكنية تستوعب ٢٠٠٠ أسرة . وقد تم بالفعل تنفيذ وشغل ٥٠٠ وحـدة



السادة الزوار .. والمهندسون يتفقدون مبانى المجمع وقطاع للانشاءات الضخمة التى تجرى فيه والتى تجرى فيها أيضا عمليات التركيبات فى تصميم دقيق تمهيدا لبدء الانتاج مع العيد الأول لأعياد النصر

سكنية ويجرى تشطيب مثلها ويتم تنفيذ بقيـــة الوحدات قبل نهاية هذا العام حتى يجد كل عامل بالمجمع سكنا مريحا وظروفا اجتماعية مناسبة .. وفى سبيل توفير هذه الظروف المناسبة ضمت المدينة السكنية كل المرافق والخدمات .

المجمع والمستقبل

وهكذا يتكامل التخطيط للعمل الانتاجى مع تخطيط للخدمات بشكل يضمن نجاحا كاملا وتطبيقا لقاعدة ان النجاح يغرى بالمزيد من النجاح فقــد اعتمــد المهندس ابراهيم سالم محمدين وزير الصناعة خطة للتوسع فى الانتاج .. وسيتم فى مارس القادم التعاقد على المرحلة الأولى من هذه الخطــة بهدف زيادة الانتاج بنسبة ٤٠ فى المائة بحيث ترتفع الطاقة الانتاجية للمجمع الى ١٤٠ الف طن قيمتها ٥٦ مليون جنيه وتفتح البـاب أمام ١٠٠٠ عامل جديد وترفع استخدام المجمع من كهرباء الســد العالى الى ٣ مليارات كيلو وات ساعة سنويا وتبدأ الانتاج خلال سنة ١٩٧٦ تفتح أمام مصر بابا جديدا من أبواب المستقبل .

وفى نهاية الزيارة لاحظ المهندس ابراهيم سالم محمدين وزير الصناعة أن الخبرة المصرية المدربة استطاعت أن تتحمل مسئولية القيام بكافة التركيبات الصناعية والميكانيكية وفقا للمواصفات الهندسية والفنية التى تصل مع المعدات .

وأشار سيادته بجهود الرجال الذين يواصلون معركتهم فى سباق مع الزمن ليبعثوا الحيـــاة فى صحراء نجـع حمادى . انهـا روح النصر تعبـر بالاقتصاد المصرى والصـــناعة المصرية الى آفاق التقدم والرخاء ..

نشـــاط

المؤسسة المصرية العامة لمقاولات المباني وشركاتها

خلال العام المـــالى ١٩٧٣

تقوم المؤسسة والشركات التابعة لها وعددها ١٧ شركة (منها شركتان تخصصيتان هما الشركة العامة للأساسات والشركة العـــامة لمقاولات الأعمـــال الصحية) بتنفيذ أعمال فى مجالات التشييد المختلفة داخل وخارج الجمهورية فى حدود ٤٣ مليون جنيه سنويا (٣٨ مليون جنيه داخل الجمهورية ، ٥ مليون جنيه خارج الجمهورية) . وقدر حجم الأعمال التى قامت بتنفيذها شركات المؤسسة من بدء العـــام المالى الحالى وحتى ٧٣/٩/٣٠ ــ قبل بدء العمليات الحربية فى أوائل أكتوبر الماضى وما ترتب على ذلك من ايقاف العمل بجميع الأعمال فضلا عن مساهمة معظم شركات المؤسسة فى تقديم مالديها من وسائل النقل والامكانيات الأخرى الى الأعمال المتعلقـــة بالمجهود الحربى ــ بحوالى ٢٥٫٦٠٠٫٠٠٠ جنيهـــا داخل الجمهورية مايعادل ٨ مليون جنيه خارج الجمهورية .

أى يبلغ اجمـــالى ماتم تنفيـــذه بحـــوالى ٣٣٫٦٠٠٫٠٠٠ جنيه وفيما يلى بعض المشروعات الهامة التى تقوم بتنفيذها شركات المؤســـسة :

١ ــ مجمع الحديد والصلب وتقدر قيمة الاعمال التى تقوم بتنفيذها شركة النيل العامة للخرسانة المسلحة (سبيكو) بحوالى ٨ مليون جنيه .

٢ ــ فندق شيراتون وقامت بتنفيذه شركة النيل العـــامة للخرسانة المسلحة (سبيكو) وتبلغ تكاليفه حوالى ١٫٥ مليون جنيه .

٣ ــ مستشفى طنطا الجامعى وتقوم بتنفيذه شركة الشمال العامة للمقاولات وتقدر قيمة هذه العملية بمبلغ ٢ مليـــون جنيه .

٤ ــ مستشفى المطرية العام وجارى تنفيذه بمعرفة شركة الشمال العامة للمقاولات وتقدر قيمته بحوالى مليون جنيه .

٥ ــ اسكان ٢٣ يوليو بالمعادى وجارى تنفيذه بمعرفة شركة الشمال العامة للمقاولات وتبلغ تكاليفه بحوالى ٤٠٠ ألف جنيه .

٦ ــ مبانى جامعة القاهرة وتقوم بتنفيذها شركة الشمال العامة للمقاولات وتقدر قيمتها بحوالى ٥٠٠ ألف جنيه .

٧ ــ مصنع السكر بابو ترقاص وتقوم بتنفيذه شركة أطلس العامة للمقاولات وتبلغ قيمته حوالى ٣٠٠ ألف جنيه .

٨ ــ مصنع الفوسفات بالحمراوين وتقوم بتنفيذه شركة أطلس وتبلغ قيمته حوالى ٤٫٥ مليون جنيه .

٩ ــ عمارة معروف بشارع رمسيس وتقوم بتنفيذها شركة أطلس العامة للمقاولات وتبلغ قيمتها حوالى ٤٢٥ ألف جنيه .

١٠ ــ مبنى المجمع العمالى بشارع الجلاء وقد قامت بتنفيذه شركة اطلس وبلغت اجمالى تكاليفه حوالى ٣٤٠ ألف جنيه .

١١ ــ اسكان محافظة الغربية وتقوم بتنفيذه شركة الدلتا العامة للمقاولات وتقدر تكاليفه بحوالى ٤٠٠ ألف جنيه .

١٢ ــ معهد التكنولوجيا بحلوان : وجارى تنفيذه بمعرفة شركة الدلتا ويقدر قيمته بحوالى ٧٥٠ ألف جنيه .

١٣ ــ مستشفى المحلة الكبرى : وجارى تنفيذه بمعرفة شركة الدلتا وتبلغ قيمته حوالى ٤٠٠ ألف جنيه .

١٤ ــ مركز التنمية الدولى بمريوط : وجارى تنفيذه بمعرفة شركة الدلتا وتقدر تكاليفه بحوالى ١٫٥ مليون جنيه .

١٥ ــ عمليات الاسكان بالقبارى بالإسكندرية ومسند تنفيذها الى شركة الاسكندرية العامة للمقاولات وتبلغ قيمتها حـــوالى ٤٢٠ ألف جنيه .

١٦ ــ مبنى مجمع الملاحة البحرية بالاسكندرية وتقوم بتنفيذه شركة اسكندرية العامة للمقاولات وتقدر تكاليفه بحوالى ٤٤٠ ألف جنيه .

١٧ ــ مبنى معهد بحوث البترول بمدينة نصر وتقوم بتنفيذه شركة الجيزة العامة للمقاولات وتقدر تكاليفه بحوالى مليـــون جنيه .

١٨ ــ عمارات صلاح سالم وبرجى الجيزة وقد قامت بتنفيذهما شركة الجيزة العامة للمقاولات ويبلغ اجمالى تكاليفها بحوالى ١٫٤٠٠٫٠٠٠ جنيها .

١٩ ــ عمارات اسكان محافظة الدقهلية وقد قامت بتنفيذها شركة الجيزة العامة للمقاولات وبلغت قيمتها حوالى ٨٠٠ ألف جنيه .

٢٠ ــ مصنع سيد بأسيوط : وتقوم بتنفيذه شركة الوادى الجديد العامة للمقاولات وقد بلغت تكاليفه حوالى ٦٠٠ ألف جنيه .

٢١ ــ مبانى كلية الزراعة بجامعة أسيوط : وتقوم بتنفيذه شركة الوادى الجديد وتبلغ تكاليفه حوالى ٧٥٠ ألف جنيه .

٢٢ ــ عمارات الترسانة : وقامت بتنفيذها شركة الوادى الجديد وقد بلغت تكاليفها حوالى ٩٠٠ ألف جنيه .

٢٣ ــ مضرب أرز رشيد : وتقوم بتنفيذه الشركة العربية العامة للمقاولات وتقدر تكاليفه بحوالى ٦٠٠ ألف جنيه .

٢٤ ــ عمارات الاسكان بامبابة : وقامت بتنفيذه الشركة العربية العامة للمقاولات وقد بلغت تكاليفه حوالى ٧٠٠ ألف جنيه .

٢٥ ــ اسكان دربالة وفكتوريا بالاسكندرية : وتقوم بتنفيذه الشركة العربية العامة للمقاولات وتقدر قيمته بحوالى ٥٠٠ ألف جنيه .

٢٦ ــ كليات الهندسة العلمية والمدنية بجامعة الازهر بمدينة نصر وتقوم بتنفيذها الشركة العربية وتقدر قيمتها بحوالى ٨٠٠ ألف جنيه .

٢٧ ــ الجهاز المركزى للتعبئة والاحصاء بمدينة نصر : وقد قامت بتنفيذه الشركة العربية وتقدر تكاليفه بحوالى ٨٥٠ ألف جنيه .

٢٨ ــ مبانى بكلية الشرطة بمدينة نصر : وتقوم بتنفيذها شركة القنال العامة للمقاولات وتقدر قيمتها بحوالى ٥٥ ألف جنيه .

٢٩ ــ معهد البلهارسيا بامبابة : وتقوم بتنفيذه شركة القنال العامة للمقاولات وتقدر تكاليفه بحوالى ٥٥٠ ألف جنيه .

٣٠ ــ اعمال بمجمع الحديد والصلب : قامت بتنفيذها شركة الجمهورية العامة للمقاولات وتقدر قيمتها بحوالى ٢٧٠ ألف جنيه .

٣١ ــ عمارات الميرلاند بمصر الجديدة : وتقوم بتنفيذها شركة الجمهورية العامة للمقاولات وقد بلغت قيمتها حوالى ١ر٢٥٠٠٠ جنيه .

٣٢ ــ مستشفى شبرا العام : وقامت بتنفيذه شركة الجمهورية وقد بلغت تكاليفه حوالى ٦٠٠ ألف جنيه .

٣٣ ــ مضرب أرز أبى حمص : وقامت بتنفيذه شركةالجمهورية العامة للمقاولات وتقدر قيمته بحوالى ٦٠٠ ألف جنيه .

٣٤ ــ مصنع الورق « فارتا » باسكندرية : وتقوم بتنفيذه شركة المحمودية وتقدر قيمته بحوالى ٤٥٠ ألف جنيه .

٣٥ ــ مركز التدريب المهنى بوردان بمحافظة الجيزة وتقوم بتنفيذه شركة المحمودية وتقدر تكاليفه بحوالى ٥ر٢ مليون جنيه .

٣٦ ــ مصنع الغزل المتوسط بسوهاج : وتقوم بتنفيذه شركة الصعيد العامة للمقاولات وتبلغ تكاليفه حوالى ٥ر١ مليون جنيه .

٣٧ ــ مطحن قنا واسنا : وتقوم بتنفيذهما شركة الصعيد وقد بلغت تكاليفهما حوالى ٣٥٠ ألف جنيه .

٣٨ ــ مبنى الامن الصناعى بمصر الجديدة : قامت بتنفيذه شركة الصعيد وقد بلغت تكاليفه حوالى ٢٢٠ ألف جنيه .

٣٩ ــ سنترال رمسيس بالقاهرة : وتقوم بتنفيذه شركة القاهرة العامة للمقاولات وتقدر تكاليفه بحوالى ٥٠٠ ألف جنيه .

٤٠ ــ مبانى شركة القاهرة للزيوت والصابون : وتقوم بتنفيذها شركة القاهرة العامة للمقاولات . وتقدر تكاليفها بحوالى ٨٠٠ ألف جنيه .

٤١ ــ مصنع الطوب الرملى بمدينة نصر : وتقوم بتنفيذه شركة القاهرة وتقدر تكاليفه بحوالى ٧٢٠ ألف جنيه .

٤٢ ــ مساكن شركة الفوسفات بالقصير : وتقوم بتنفيذها شركة البحر الاحمر العامة للمقاولات وتقدر تكاليفها بحوالى ٧٥٠ ألف جنيه .

٤٣ ــ المستشفى العام بالغردقة : وتقوم بتنفيذها شركة البحر الاحمر وتقدر تكاليفه بحوالى ٣٧٠ ألف جنيه .

٤٤ ــ مبنى هيئة التأمينات الاجتماعية بالقاهرة : وقامت بتنفيذه شركة البحر الاحمر وتقدر تكاليفه بحوالى ٧٤٠ ألف جنيه .

٤٥ ــ مجمع محاكم طنطا : وتقوم بتنفيذه الشركة المصرية للمبانى الريفية وتقدر تكاليفه بحوالى ١٥٠ ألف جنيه .

٤٦ ــ مبنى مديرية الامن بطنطا : وقامت بتنفيذه شركة المبانى الريفية وتقدر تكاليفه بحوالى ١٠٠ ألف جنيه .

هذا بالاضافة الى مساهمة معظم شركات المؤسسة مساهمة فعالة فى تنفيذ المشروعات المتعلقة بالاشغال العسكرية والمجهود الحربى .

هذا ويتبع المؤسسة ٢ مراكز للتدريب المهنى على حرف البناء بكل من القاهرة والاسكندرية . وهذه المراكز تتولى تخريج عمال حرفيين نصف مهرة على نظام التدريب السريع فى حرف البناء والبياض والخرسانة والصحى والنجارة .

المؤسسة المصرية العامة لمقاولات الانشاءات المدنية

- الشريان الذي يغذي قلب الأمة العربية ، ويحملها على طريق الوحدة الشاملة
- رسالتها .. أن تعطي كل الامكانيات .. والخبرة من أجل مستقبل بلادنا .. والوطن العربي كله

على طريق الغد ، تمشى الأمة العربية بالأمل والعمل .. فان الشعوب العربية تحلم باليوم الذى تلتقى فيه كلها ، لتكون أمة كبيرة وعظيمة ، ولتعيد تاريخها المجيد : ولتبنى حاضرا ومستقبلا .. وهناك خطوات على طريق هذا الأمل ، تجعل من اليوم المرتقب حقيقة دانية يشعر بها كل انسان عربى فى تلك الخطوات المتلاحقة البناءة .

ومن بين الخطوات الايجابية على طريق اللقاء العربى الكبير للأمة العربية الواحدة تلك الصورة المشرقة التى نقدمها بكل ما فيها من أمل وبكل ما تحمله من معانى الترابط الوثيق والتى تمس قطاعا حيويا يمثل أهمية كبرى فى حياة الشعوب هو قطاع التشييد والبناء .

فهناك حقيقة هامة .. لأنها تمثل منطلقات العمل فى هذا القطاع الحيوى الهام .. وهى أن هذا القطاع يبذل من أجل حركة البناء والتشييد فى الوطن العربى من الجهد والعرق والكفاءة على نحو ما يبذل من أجل هذه الحركة فى الداخل . وهذا عن ايمان عميق بأن تحقيق التقدم فوق أى شبر عربى انما هو تقدم الأمة العربية كلها .

ولقد شاركت **المؤسسة المصرية العامة لمقاولات الانشاءات المدنية وشركاتها** .. فى تنفيذ عديد من المشروعات الهامة والحيوية فى مختلف الدول العربية الشقيقة .. والافريقية الصديقة .. وما زالت تحمل أمانة هذه الرسالة وتعطى لها كل الامكانيات والخبرة والكفاءة الفنية لتكون على أرقى المستويات العالمية . وبشهادة الخبراء العالميين فان هذه الشركات قد وصلت الى مستوى المنافسة العالمية . وانها قد حققت تقدما مذهلا فى مجال البناء والتشييد .. وفى تقدير الخبراء أيضا أن هذا الدور هو امتداد لتاريخنا العظيم فى هذا الميدان ، فالفراعنة قد بنوا للخلود ، ونحن اليوم نبنى للحياة والمستقبل .. ومن أجل الخير والسلام .

ان شركات المقاولات عندنا تنتظر أسمى وأقدس مهمة .. ولا شك أن حجم العمل الذى ينتظرها ضخم وكبير . فهناك أربعة محافظات عزيزة وغالية على قلب كل مصرى .. وهى محافظات القناة وسيناء .. وهى فى حاجة الى اعادة بنائها وتخطيطها لتواصل مسيرة الحياة ... غدا سينطلق جيش المهندسين والفنيين والعمال . بكل الخبرة والامكانيات والحب والاخلاص والجهد والعزيمة ، لبناء حياة جديدة باسمة فيها كل أسباب الحياة العصرية من مساكن حديثة ومدارس ومرافق ومستشفيات ومصانع ..

والمؤسسة وشركاتها لديها من الامكانيات والخبرات ما يتيح لها أن تنجز ذلك كله ، فى وقت سريع وعلى أرقى المستويات .

وبايجاز يمكن أن نقول ان تصميمات المؤسسة وشركاتها أصبحت واضحة الآن فى انطلاق الحياة الجديدة فوق الرقعة العربية .. كذلك فان رسالتها نحو الوطن العربى مستمرة وسوف تبذل فى هذه المشروعات العربية كل ما لديها من خبرة وطاقة وامكانيات لتسير الأمة العربية كلها فوق أرض التقدم والحضارة وتستعيد مكانتها العظيمة التى كانت لها والتى تنتظرها فى المستقبل .

ويتبع المؤسسة احدى عشر من أكبر الشركات العاملة فى قطاع التشييد والبناء وهى :

١ - شركة المقاولات المصرية :

تقوم بتنفيذ مشروع الحديد والصلب فى جمهورية الجزائر ، وتصل تكاليفه الى ١٠ مليون دينار جزائرى . كذلك مشروع الانارة الريفية لولايات غرب الريف الجزائرى وتكاليفها ١٠ مليون دينار بالاضافة الى مشروعات أخرى تصل تكاليفها

الى ٢٥ مليون دينار وقد استطاعت الشركة بحرصها الشديد وقدرتها أن تتمتع باحترام وثقة .. حكومة الجزائر مما جعلها تنفذ كل هذه الأعمال السابقة اما فى مصر .. فقد قامت بتنفيذ جزء من شبكات السد العالى ومحطة محولات غرب القاهرة وهى تعتبر ثانى محطة محولات فى العالم وتكاليفها ٣ر١ مليون جنيه ، محطة غرب القاهرة وهى أكبر محطة حرارية فى الشرق : وتكاليفها ٢ مليون جنيه .

مصنع سكر دشنا ٥ر٤ مليون جنيه ، معمل تكرير البترول بالعامرية ٤ر١ مليون جنيه ، مجمع الحديد والصلب بحلوان ٥ر١ مليون جنيه محطة كهرباء كفر الدوار ٢ مليون جنيه ، خزانات بترول قنا ٦٠٠ ألف جنيه ، محطة مياه شمال شرق القاهرة ٢ مليون جنيه ، مجارى شارع الهرم ٢ مليون جنيه، محطة مياه التبين ٧ر١ مليون جنيه ، محطة مياه شبراخيت ٧٠٠ ألف جنيه : مستشفى قنا العام ٧٠٠ ألف جنيه ، مستشفى سوهاج مليون جنيه ، ورش وجراجات هيئة النقل العام ٢ مليون جنيه ،

٢ ــ الشركة المساهمة المصرية للمقاولات :

تقوم بتنفيذ ٨٢٨ وحدة سكنية فى طرابلس ــ ليبيا تتكلف ٥ ملايين دينار ليبى .

وفى الكويت قامت بانشاء قاعدة الصيانة لمؤسسة الطيران الكويتية بمطار الكويت . كذلك أقامت مدرسة الشعب ومدرسة حولى ومحطة الطلمبات والمبنى الرئيسى للمواصلات السلكية واللاسلكية بالكويت هذا بجانب العمارات السكنية التى أقامتها هناك ..

أما فى مصر ... فان أهم أعمال الشركة المساهمة المصرية للمقاولات تتركز فى :

اقامت مصانع الحديد والصلب بحلوان ، ومصنع درفلة الشرائط على الساخن والمبانى المساعدة ومصنع الصوف التوبس بكفر الدوار وهو يعتبر أول مصنع من نوعه فى الشرق وتكاليفه مليون جنيه ومصانع الغزل والنسيج بالمحلة ودمياط وكفر الدوار ومصنع الخشب المضغوط بفارسكور . وقد بلغت قيمة أعمال الشركة ٣٨ مليون ، ٨٠٠ ألف جنيه ، هذا بالاضافة الى أعمال أخرى مثل المركز الرئيسى لبنك مصر ... ومستشفى الجمعية الخيرية الاسلامية بالقاهرة . والمدينة السكنية لشركة مصر بكفر الدوار والمدينة السكنية لشركة مصر للحرير الصناعى .

مصنع غزل كفر الشيخ ٥ر١ مليون جنيه المدينة السكنية لمصنع الأسمدة ٤٣٢ ألف جنيه عمارة النصر بالجيزة ٣٢٠ ألف جنيه ، مبنى التشريح بطب القاهرة ٤٠٠ ألف جنيه .

٣ ــ شركة النصر للمبانى والانشاءات :

تخصصها فى الأعمال البحرية وخبرتها فيها تصل الى ثلاثين عاما . وتملك الشركة كراكة للتطهير لعمق ٢١ مترا وبقدرة ٥٠٠ متر مكعب فى الساعة وأهم أعمالها اقامة رصيف الترسانة البحرية وحواجز الأمواج البحرية فى الاسكندرية : اقامة أساسات مصانع الاليكترونيات ببنها والورق الأهلية وراكتا والنشا والجلوكوز ومحطة الكهرباء بحلوان .. ومصنع تجفيف البلح بالبدرشين ومصنع عصير الفاكهة بأبى كبير ، ومبنى جامعة أسيوط ومساكن الطلبة ومدارس المنيا ومعهد القياس والمعايرة بالهرم .

ومصنع رقائق الالمونيوم ٤٥٠ ألف جنيه المدابغ النموذجية بالبساتين ٧ر١ مليون مبنى انتاج الأدوية بشركة هوكست ٦٥٢ ألف جنيه ، عمليات مختلفة بشركة الترسانة البحرية ٧٠٠ ألف جنيه رصيف المعدات لمجمع الحديد والصلب بسمالوط ٤٢٧ ألف جنيه ، ومبانى جامعة المنصورة ٤ مليون جنيه .

٤ ــ الشركة العامة للانشاءات :

لعل أهم ما انشأته مفخرة البناء والصحافة.. مبنى مؤسسة الأهرام الجديدة التى بلغت تكاليفها مليون جنيه . يضاف الى ذلك فندق فونتانا الذى يعتبر نموذجا للبناء وليست هذه هى أهم أعمال فقد أقامت مصانع راكتا للورق بالأسكندرية ومصانع النقل والهندسة بالاسكندرية توسيع مصانع كيما بأسوان . عمارات اسكان مدينة نصر والشيخ هارون وكسير الحجر بادفو وأسوان . منشاة ٢٣ يوليو السكنية والمؤسسة الاقتصادية بالاسكندرية . مشروع ناصر للاسكان بالحضرة ، والمستعمرة السكنية بأسيوط . أساسات كلية الطب ومحطة كهرباء أسيوط فندق شبرد وأبى سمبل ودار الكتب ووزارة الكهرباء ومجمع أسوان ومستشفيات حلوان وشبرا الخيمة وأسوان كما قامت الشركة بتنفيذ الكثير من المنشئات الرياضية، منها مدرجات أستاد القاهره الذى يعتبر أكبر أستاد رياضى فى الشرق الأوسط .

ولا تتوقف أعمال الشركة داخل الحدود . انها تتعدى ذلك الى الخارج أيضا . فتقوم بانشاء فندق الصداقة بباماكو بجمهورية مالى ــ أساسات عمارة النصر بابيدجيات بجمهورية ساحل العاج . وقد تكلف الفندق ثلاثة ملايين جنيه استرلينى . ويعتبر من أعظم الفنادق السياحية بافريقيا . وكذلك أقامت عمارة شركة النصر بنيامى عاصمة النيجر وتكلف المبنى مليون ونصف مليون جنيه استرلينى.

٥ ـ شركة النيل العامة للمقاولات :

لها نشاط فى كل اتجاه ـ فقد قامت بانشاء مصنع نسيج بنى سويف ومصنع الغزل الرفيع بالمحمودية . شركة الورق الأهلية ، كذلك أقامت الترسانة البحرية بالاسكندرية وعدد من الكبارى فى القاهرة وطنطا . مشروع ناصر للاسكان .

مستشفى دمنهور العــام . المركز الثقافى والاجتماعى بالاسماعيلية . .

توسعات مصنع اسمنت طره ٦٨٠ الف جنيه .

ـ مصنع الشفرات المعدنية بالاسكندرية ٤٠٠ ألف جنيه ـ مصنع الحراريات والألياف الصناعية ٣٠٠ ألف جنيه ـ محطة كهرباء منوف ، محطات محولات قويسنا : البساتين ، الزاوية ، الملاك وكل منها بتكاليف ٣٠٠ ألف جنيـه ـ مخـزن الترام المفصلى ١٫٥ مليون جنيه ، مستشفى المنيا العـام ٧٠٠ الف جنيه .

وقد بلغت قيمة أعمال شركة النيـل العـامة للمقاولات أكثر من ١٥ مليون جنيه .

٦ ـ شركة النيل العـامة للكبارى :

تختص بالأعمال الخاصة بالكبارى ، سواء كانت علوية أو كبارى ثابتة ، أو كبارى متحركة وقد قامت بتنفيذ ٢٥ كوبريا فى مختلف المحافظات منها كوبرى بركة السبع وكوبرى بحيـرة التمسـاح وكوبرى يوسف وكوبرى الاسماعيلية . وكلها كبارى علوية .

كذلك قامت بتنفيذ كبارى الجمالية وسرسنا ومحلة أبو على . وكلها كبارى متحركة وقامت أيضا بانشاء كبارى فم الخليج وسيالة الروضة والمكس وبحر الملاح ومصرف خيرى وأبو قير ومدخل المنيا وكلها كبارى ثابتة . ثم أقامت كبارى صناعية على بحر طناح .

وكذلك هويس ك ١٠٠ على ترعـة النوبارية مليون جنيه ـ كوبرى وهويس ك ٦١ على ترعـة النوبارية مليون جنيه ـ محطات طلمبات الصرف بالمحافظات المختلفة ١٫٦ مليـون جنيه ـ مصانع مواسير الصرف المغطى ٦٠٠ ألف جنيه ـ جراجات هيئة النقل العام بشمال القاهرة ٢٫٥ مليون جنيه ـ نفق شبرا المظلات ٦٠٠ ألف ـ ترعة الخندق الشرقى مليون جنيه ـ هويس المالح والكبـارى الملحقـة ٣ مليون جنيه .

٧ ـ شركة النصر للأعمال المدنيـة :

تبلغ قيمة أعمالها أكثر من ١٥ مليون جنيه . وهذه الأعمال تتركز فى أعمال الرى والزراعة ومنها مشروعات تحـويل رى الحيـاض الي ري دائم في محافظات أسيوط وسوهاج وقنا ، ومحطات طلمبات الرى والصرف فى شرق ووسط وغرب الدلتا .

كذلك قامت بتنفيذ محطات طلمبات النوبارية رقم ٢ وذلك لاستصلاح ما يزيد على ٢٠٠ ألف فدان بالنوبارية . هذا بجوار أعمال الأهوسة والقناطر الكبرى .

وهويس ترعة النوبارية ٨٠٠ ألف جنيه ـ هويس فم رياح البحيرة ١٫٢ مليون جنيه ـ مصرف ساقولا الرئيسى وامتداده ١٫٩ مليون جنيه ـ محطة رقم ٥ على ترعة النصر بمريوط ١٫٥ مليون جنيه ـ محولات شرق القاهرة ١٥٠ ألف جنيه ـ التحكم المركزى بطلخا ٢٥٠ ألف جنيه ـ محولات المنشية ٢٠٠ ألف جنيه ـ عمليــة زاوية غزال ١٢٠ ألف جنيـه .

٨ ـ الشركة العربية للأساسات :

تختص بأعمال الخوازيق الفيبرو ولذلك فقد اشتركت فى تنفيذ أعمال كثيرة منها أساسات لمصانع كبرى ... الى جانب جامعـة الدول العربيـة والهيلتون ومؤسسة الأهرام الجديدة ودار الهلال ومحطات كهرباء وأبراج خطوط السد العالى ونفق غمرة .

٩ ـ شركة النصر للمرافق والتركيبات :

تقوم بعمل التركيبات الميكانيكيـة للمبانى ... بجوار قيامهـا بتوريد وتركيب محطـات الديزل الثابتـة والمحركات الكهربائية ولوحـة التوزيع ـ وأجهزة تنقية مياه الشرب وتنقية مياه المجـارى وتصنيع طلمبات مياه الشرب وأجهزة اضافة الكلور والكيماويات .. وتقوم كذلك بتنفيذ وانشاء ٢ محطة أبار انتاجية .

وازدواج خط مواسير بسان ٤٠٠ الف جنيه تغذية منطقة الملاك ١١٠ ألف جنيه ، مصنع كربونات الصوديوم بالاسكيدرية ٦٤٠ الف جنيه الى جانب تركيب محطات مياه كفر الشيخ ٥٠٠ ألف جنيه ، أسيوط ٣١٠ ألف جنيه ـ مخطات مجارى .. كفر الشيخ ٣٨٧ الف جنيه ، المنصورة ٤٣٤ الف جنيه مصنع الأسمدة ٢٥٠ ألف جنيه : الفيوم ٢٨٢ ألف جنيه . الى جانب تخصصها فى الانشاءات المدنيـة والأعمال الميكانيكية للمحطات والمرافق العـامة والخزانات العالية . كذلك تنفيذ شبكات المواسـير وقد نفذت فى هذا المجال محطـة رفـع وأحواض التنقية ومجمعات مشروع المجارى العاجلة المسمى بالمائة يوم بالقاهرة . كذلك انشاء أحواض التجفيف بأبى رواش ومحطات مياه بور سعيد والسويس ومشروع ناصر ومريوط .

١٠ ــ شركة المشروعات الصناعية والهندسية :

تعتبر واحدة من أكبر شركات المؤسسة . وذلك لنشاطها حيث نفذت عددا كبيرا من المشروعات منها فى قطاع البترول .

ـــ مشروع رأس شقير . وقد استحقت عنه مكافأة ٣٠٤ ألف دولار ، بعد أن نفذت المشروع قبل الموعد المتفق عليه .

ـــ خطوط البترول بين المكس . طنطا . السويس مسطرد . القاهرة . وطولها ١٥٠ كيلو مترا وقد بلغت تكاليفها مليون ونصف مليون جنيه .

ـــ مشروع العلمين وقيمته ٣٨٠ ألف جنيه .

ـــ مصنع هدرجة الزيوت بالمنصورة ٢٥٠ ألف جنيه ، المجمع الصناعى بالمنصورة ٣٠٠ ألف جنيه ، انارة قرى الجيزة والفيوم ٥٣٠ ألف جنيه ، مصنع هدرجة الزيوت بالزقازيق ٤٥٤ ألف جنيه ، مركز تدريب هيئة النقل العام بالقاهرة ٥٠٠ ألف جنيه ، خط غازات أبوماضى طلخا ٤ر١ مليون جنيه .

أما فى قطاع الرى والصرف فقد نفذت :

ـــ محطة الرفع الرئيسية بمديرية التحرير لرفع المياه اللازمة لزيادة الأراضى الزراعية .

ـــ عملية مياه دمياط المرشحة الجديدة .

ـــ توسيع محطة مياه قناة السويس
محطات مياه جنوب القاهرة ، كوم امبو ٥٥٠ ألف جنيه : أسوان ٤٣٥ ألف جنيه ، جنوب الجيزة ٩٠٠ ألف جنيه ، المنصورة ٦٥٠ ألف جنيـــه ، المنشية ٣ر١ مليون جنيه ، شمال حلوان ٧٥٠ ألف جنيه .

وفى الاسكان ، قامت بتنفيذ :

ـــ عمارات سكنية فى كل من أسوان . القبة الأميرية عمال السكر بكوم امبو . فندق كلابشة .

١ ــ الشركة العربية للأعمال المدنية :

قامت بتنفيذ مشروعات بلغت قيمتها ١١ مليون جنيه . وهذه الأعمال منها :

مشروعات صناعية وترابية للرى بمناطق ديروط وبنى خالد وطوخ الخليل والكلابية .

مشروعات تحويل الحيـــاض والصرف المغطى بمناطق هلا وقصر نصر الدين والعطف وكفر شكر .

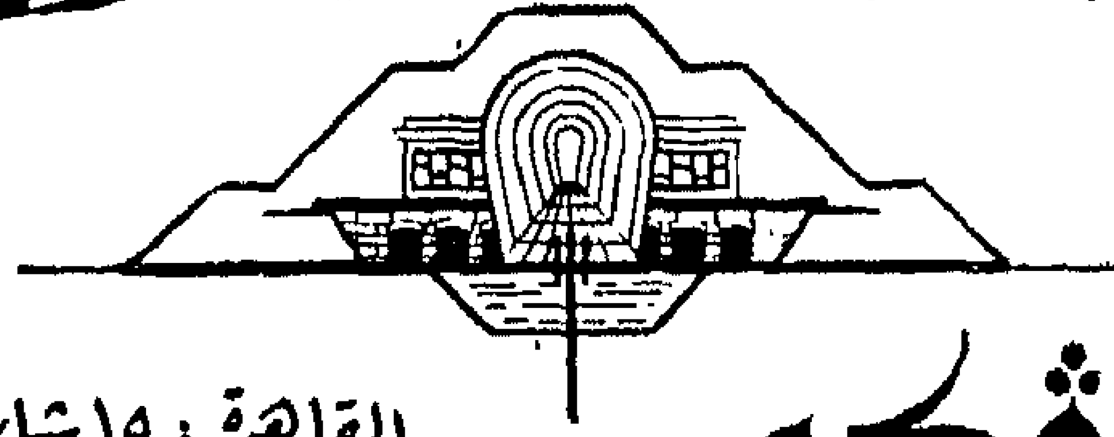
أعمال شبكات المياه والمجارى بهاكستب ومدينـــة نصر . مشروع المائة يوم تسوية الأراضى والحفر الميكانيكى والأعمال المدنية للمحطات وللمحولات .

وساهمت أيضا فى تنفيذ انقاذ معابد النوبة ، حيث قامت بفك وتركيب ونقل معابد عمدا وبيت الوالى ووادى السبوع ومقبرة بنود .

وعلى أية حال فليس هذا هو مجال تعـــداد انجازات المؤسسة وشركاتها ... فهى كثـــيرة ومتعددة وفى مختلف المجالات وانما أردنا أن نقـــدم صورة من كل ميدان من ميادين البناء والتشييد ليعبر بضخامة وتفوق عن مقدرة المؤسسة وشركاتها وامكانياتها المادية والبشرية والفنية . . . وهـــذا ما يؤكده **المهندس جمال الدين عبد الرحمن** رئيس مجلس ادارة المؤسسة . . .

وهكذا تنطلق المؤسسة وشركاتها على طـــريق البناء والتشييد فى مجالات الصناعة والمبانى العـــامة والاسكان لتقوم بدور حيوى وفعال فى دعم نهضة البلاد وتحقيق انطلاقتها الكبرى فى مواجهة التحديات الصهيونية والامبريالية . وتبذل فى العمل ما يؤكد صلابة الجبهة الداخلية ، وقدرتها على العطاء من أجل بناء المستقبل فى الظروف الصعبة . كذلك فان المؤسسة وشركاتها تعطى الكثير من الجهد والخبرة والامكانيات على المســـــتوى العربى والافريقى ، مشاركة منها فى تحقيق التطور الشامل للأمةالعربية وهى تأخذ طريقها نحو المستقبل بالعمـــل والأمل مستندة على جناحين من العلم والايمـــان . تحت قيادة الرئيس المؤمن **محمـــد أنور السادات** الذى سيكتب له التاريخ أنه رد لجماهير شعبنا الثقة على تحقيق النصر .

شركة السد العالي للأعمال المدنية



هيداسيفكو

القاهرة : ١٥ شارع الدكتور طه حسين « ولكوكس سابقاً »
بالزمالك تليفون : ٨١٢٨٤٩ - ٨١٢٨٦٠

إحدى شركات المؤسسة المصرية العامة لمشروعات الري والصرف

- إيماناً بالعمل من أجل تحقيق النصر
- معنى العمل الناجح عند بناة السد العالي
- عشرات الأعمال .. في كل إتجاه
- مساهمة الخبرات المصرية في مشروعات البلاد العربية

لا يستطيع أحد أن ينكر ان قطاع الأعمال المدنية يعتبر من انشط القطاعات العاملة في بلادنا واذا أضفنا الى هذا خبرات ومجهودات بناة السد العالي استطعنا فعلا ان نقوم بعمل على أكمل وجه من الدقة والاتقان .

والمثال : موجود لدينا في **شركة السد العالي للاعمال المدنية** التي استطاعت من خلال نشاطها أن تقدم نموذجا للعمل من أجل مصر بالرغم من مرور وقت قصير على انشائها ، واذا كان هذا يعتبر شكلا عاما للحديث ، فان التفاصيل تعطي الحقيقة كاملة .

ان ظروف العدوان برغم قسوتها لم تستطع ان تجعل **شركة السد العالي للاعمال المدنية** تقف مكتوفة الأيدي في اثبات أن الانسان المصري قادر على صنع الحياة حتى في أحلك الظروف وقادر على صنع النصر برغم كل العقبات .

واذا كان الانسان يضع على صدره أوسمة ينالها على عمل بارز قام به ، فان الشركة تضع على صدرها عشرات الأوسمة بما تقوم به من أعمال وتلك نماذج من أعمالها التي قامت وتقوم بتنفيذها .

١ ـ مشروع نفق وادي الريان . وقد بلغت تكاليفه ٦ر٥ مليون جنيه .

٢ ـ مشروع انقاذ معابد فيلة بأسوان .

٣ ـ عملية تنفيذ الأعمال المدنية بالمحطة الرابعة بمشروع النوبارية .

٤ ـ عملية شبكة المصارف المغطاة ببني صالح لمساحة ٢٤ ألف فدان .

٥ ـ الأعمال الترابية والصناعية لتعميق مصارف المنطقة الثالثة بكوم أمبو .

٦ ـ عملية تخفيف المياه الجوفية بمجمع الحديد والصلب بمنطقة الصلب المستمر بحلوان .

٧ ـ عملية تخفيف المياه الجوفية لمآخذ محطة المياه الخاصة بمجمع الحديد والصلب بالتبين .

٨ ـ عملية تشغيل وصيانة طلمبات التجفيف بمجمع الحديد والصلب بحلوان .

٩ ـ عملية شبكة المصارف المغطاة ببني مزار محافظة المنيا لـ ٧٠٠٠ فدان .

١٠ ـ تنفيذ مصرف بركة الرغامة والأعمال الصناعية التي عليه .

١١ ـ عملية نقل محطة الجلاوية بسوهاج الى موقعها الجديد ببني صالح .

١٢ ـ عملية تغذية مطار أبو سمبل بمياه الشرب من المستعمرة السكنية .

١٣ ـ عمل الاختبارات والتخريم والدراسات اللازمة لدراسة النحر بمجرى نهر النيل من أسوان الى الدلتا .

١٤ ـ عمليات شبكة الصرف المغطى بدلتا نهر النيل لمناطق سبل ٣ ، ٤ ، ٥ .

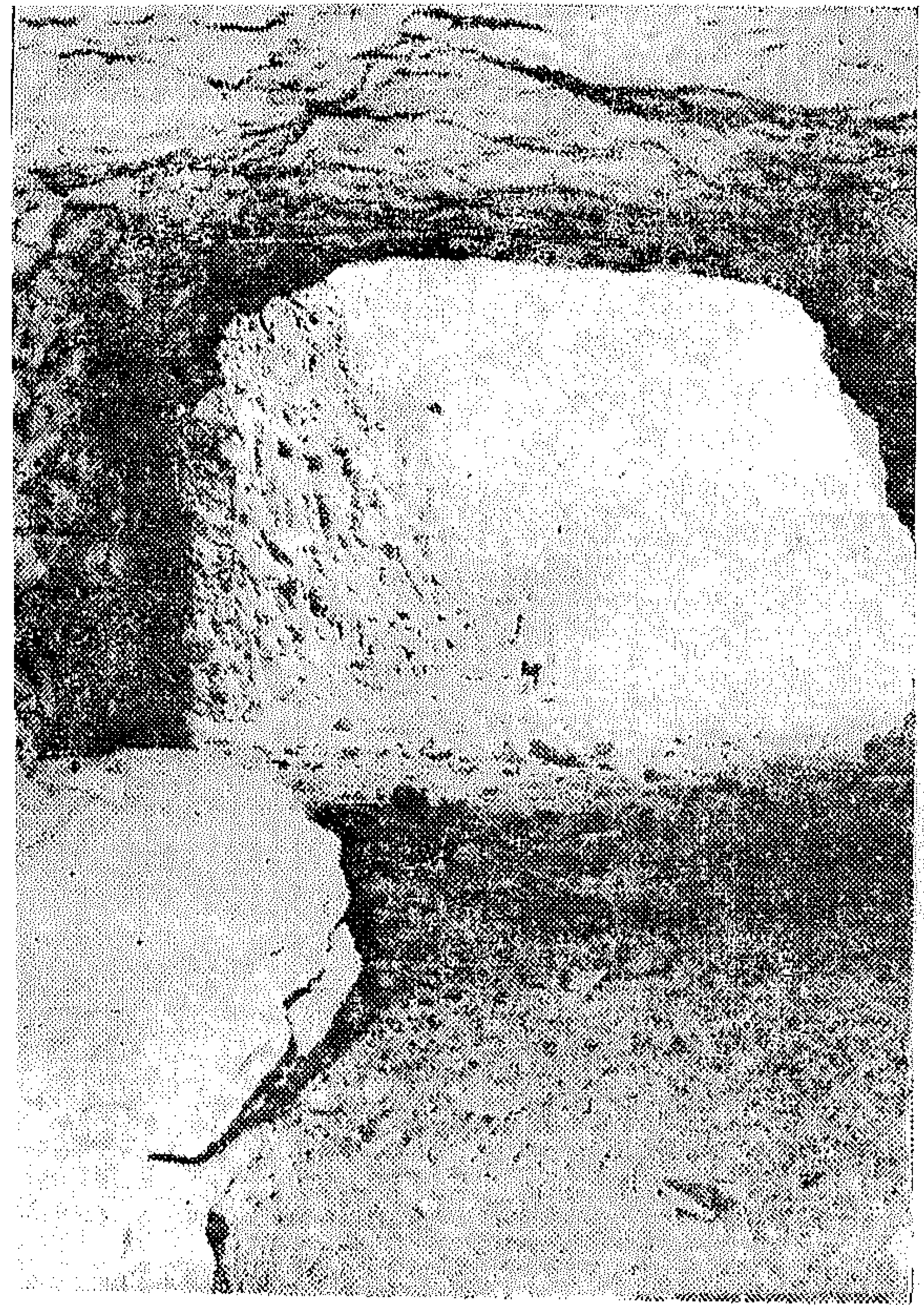
١٥ ـ عمليات المصارف المكشوفة ببني صالح .

١٦ ـ عملية استكمال مباني الورش الأميرية .

١٧ ـ مشروعات الري بكوم أمبو وتشمل العمليات الآتية :ـ

(ا) عملية تطهير وتعميق مصارف العدوة والرديسية بحري مصرف وادي عبادة ومخر السيل مع تعديل مجرى مصرف وادي عبادة من كيلو ٢٠ر٢ كيلو ٧٥٠ر٢ .

(ب) توسيع وتعميق مصارف حاجز السباعية ووصلة الصرف من حوض السباعية وحاجز البوصيلية .



الوصول بالحفر إلى مخرج نفق وادى الريان

(جـ) انشاء وصلة الصرف لمصرف حاجز ادفو .
(د) انشاء محطة طلمبات رى فرع قسطل
(هـ) انشاء مصرف مصيص وسرى القبلى وسحارة تحت ترعة كامل والأعمال الصناعية على مصرف ابريم .
(و) عملية مصرف بركة قورته على مصرف ابو هور على النيل .
(ز) انشاء المصارف القاطعة للرشح بقريتى ابريم وقسطل .

١٨ ــ انشاء مصرف البسيونى والأعمال الصناعية عليه بأسيوط .
١٩ ــ عملية توسيع وتعديل بحر الدفئة وعمل سحارة تحت مصرف رقم ٢ بمنطقة ريان .
٢٠ ــ عملية توصيل التيار الكهربائى الى :
(ا) فندق الفنتين .
(ب) مستودعات الجمعية التعاونية للبترول .
(جـ) توصيل خطوط من محطة خزان اسوان بالبر الغربى حتى السد الشرقى .
٢١ ــ أعمال شبكة الصرف المغطى بنجع حمادى .
٢٢ ــ تكسية مجرى المص لطلمبات بلبيس القبلى
٢٣ ــ الاعمال الترابية والصناعية لفروع الرى لمنطقة توسيع فارسكور .
٢٤ ــ الاعمال الترابية والصناعية لتعميق وتوسيع مصرف ايتاى البارود .
٢٥ ــ محطة كهرباء القلعة الجديدة .
٢٦ ــ عملية هدم القنطرة كيلو ٦٠٠ر٤٤ على ترعة النوبارية .
٢٧ ــ عملية الابحاث الأولية لمشروع مصنع الفيرسيليكون بادفو .

هذا ، بالاضافة الى العديد من المشروعات الجارى دراستها والتعاقد عليها فى مختلف انحاء الجمهورية والبلاد العربية الشقيقة .

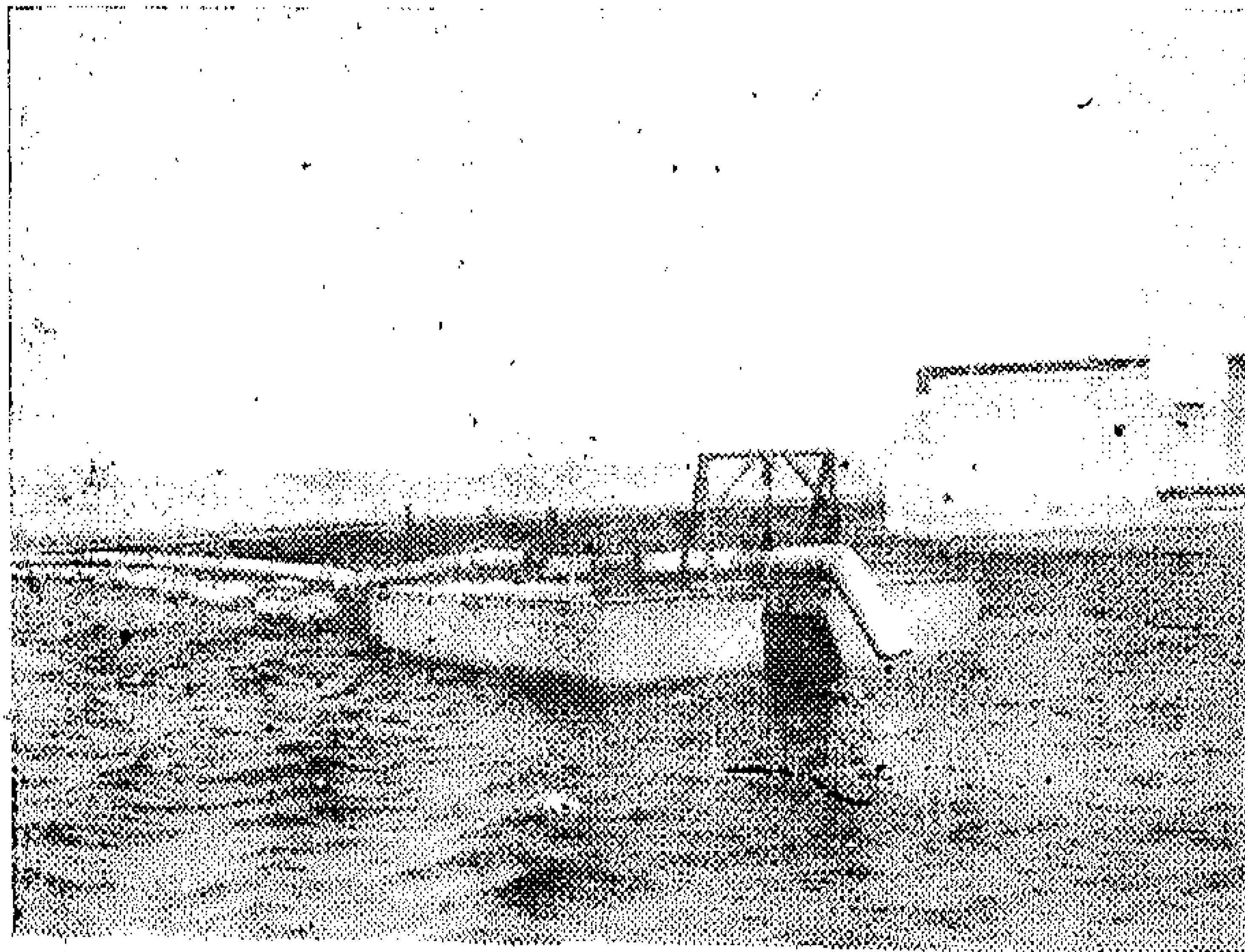
ولم تقف الشركة عند حد تنفيذ المشروعات داخل الجمهورية فليس هذا من طبع بناة السد الذين شهد لهم العالم بكفائتهم الفنية ، فالآن جاء دورهم لتقديم خبراتهم فى البلاد العربية والافريقية فالشركة تقوم حاليا بتنفيذ مشروعات بالجمهورية العربية الليبية منها :

عملية وادى كيعام .
عملية سد وادى تبريت .
عملية سد وادى كيعام .
حفر الآبار الاختبارية والانتاجية .

كما تقوم حاليا بدراسة المشروعات الكبيرة بالاقطار العربية الشقيقة وشركة السد العالى للاعمال المدنية تخصصاتها فى الاعمال الآتية :

ــ أعمال الحقن للتربة .
ــ أعمال نقل الرمال بالتجريف الهيدروليكى .
ــ انشاء السدود .
ــ حفر الآبار .

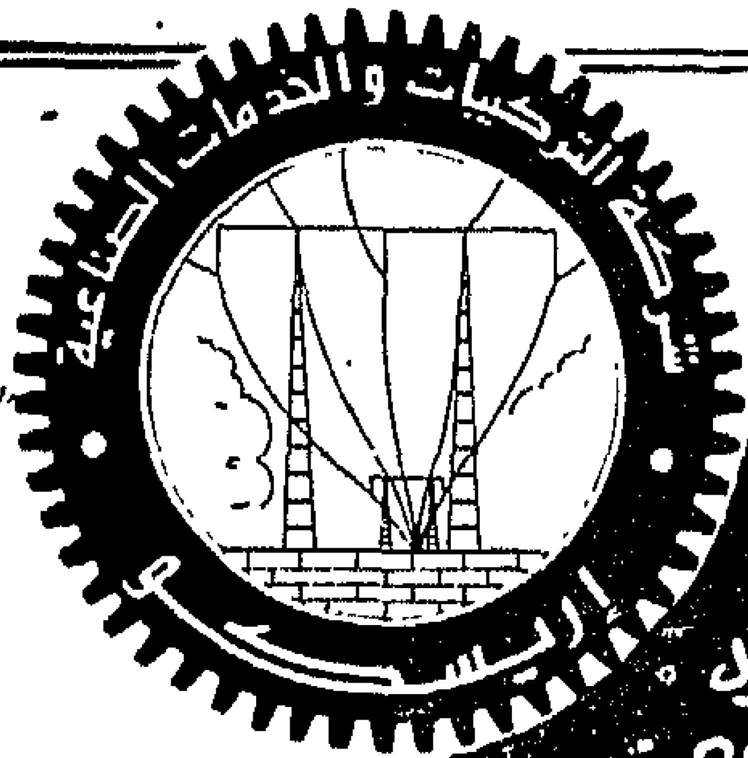
ومن خلال ذلك نرى معنى واحدا : ان العمل، والعمل وحده هو الطريق الى البناء المطلوب لتحقيق النصر ، تحت قيادة الرئيس أنور السادات الزعيم الذى سيكتب له التاريخ بحروف من نور أنه رد الى جماهير مصر الثقة بنفسها وقدرتها على تحقيق النصر باذن الله .



أعمال نقل الرمال بواسطة التجريف الهيدروليكى لإنشاء السد المؤقت حول معابد فيله ، وهى من الأعمال التى تخصصت فيها الشركة

شركة التركيبات والخدمات الصناعية

إحدى شركات المؤسسة المصرية العامة للصناعات الهندسية والكهربائية والالكترونية



إحدى دعائم الثورة الصناعية

أهداف الشركة :

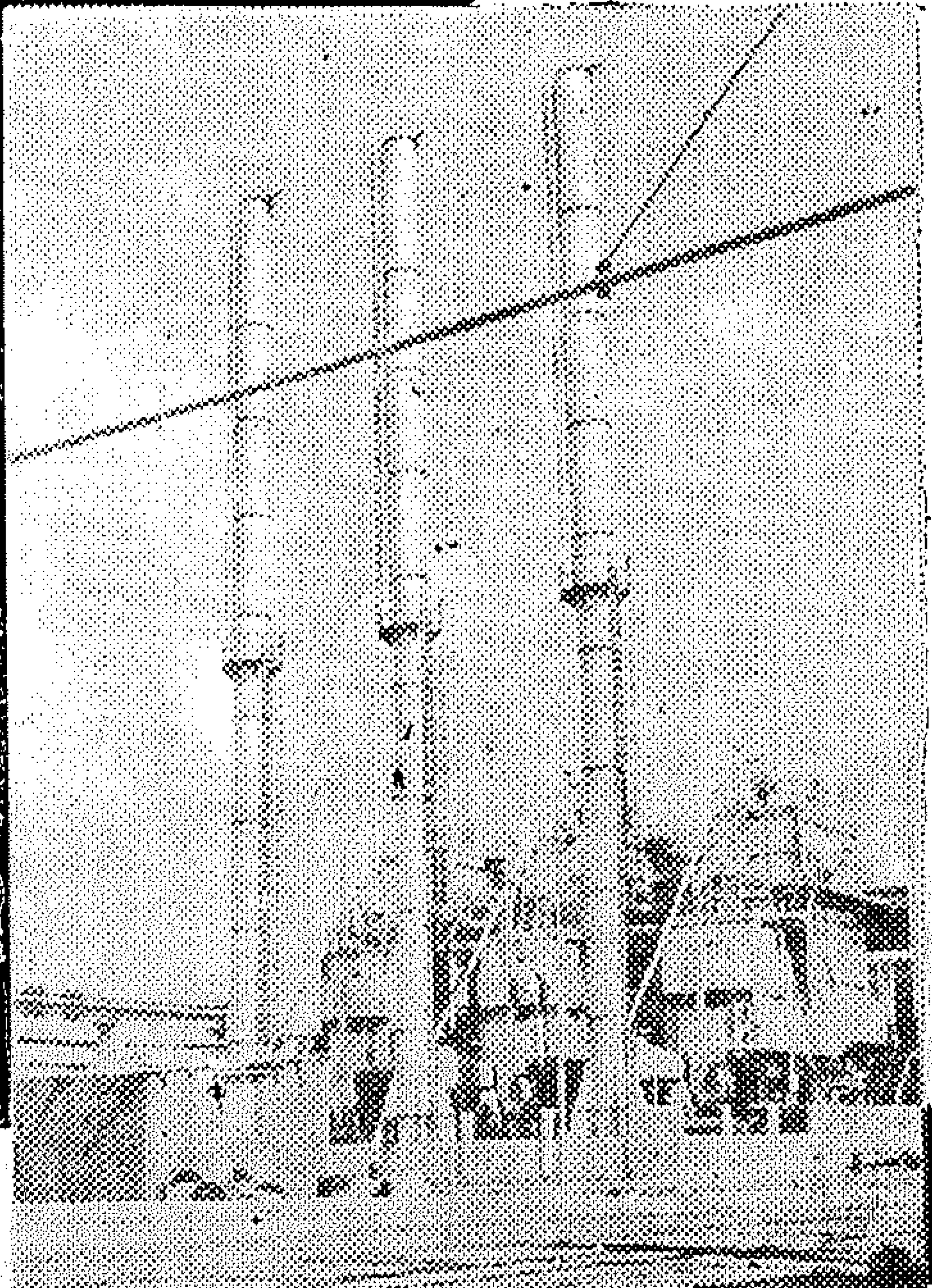
- تركيب المعدات والآلات والمهمات في الشركات الصناعية والتوصيلات الكهربائية الخاصة بها..
- تركيب الأوناش والأفران التي تحتاج إلى خبرات خاصة والتوصيلات الكهربائية الخاصة بها
- تركيب خطوط المواسير الزهر والصلب وتوصيلاتها
- تجميع الوحدات المحركة لنقل طلمبات المياه وكباسات الهواء وملحقاتها.
- تركيب مجموعات توليد الكهرباء بأنواعها : «ديزل - بنزين» وملحقاتها.
- تركيب محطات توليد الكهرباء وشبكات الضغط العالي والمنخفض والخطوط الهوائية.
- جميع الخدمات الصناعية التي تحتاجها المصانع المختلفة.

منجزات حققتها الشركة

- فك ونقل مصانع شركة مواد الصباغة بالإسماعيلية وتركيبها بكفر الدوار ، وتنفيذ الأعمال الكهربائية الخاصة بها
- التركيبات الميكانيكية والكهربائية والعزل الحراري لمكثف مياه مرسى مطروح
- تركيب خطوط الكهرباء للجهد المتوسط ١١ ك . ف بطول ٣٠٠ كم لمشروع إنارة قرى محافظة كفر الشيخ كما تم إنارة ٨٤ قرية
- مشروعات كهربة الريف بمحافظات مرسى مطروح والقليوبية ودمياط
- مشروعي الصوت والضوء بأبي سمبل
- التركيبات الميكانيكية والكهربائية للترسانة البحرية وشركة اسكندرية للمنتجات المعدنية بالإسكندرية
- التركيبات الكهربائية والعزل الحراري بمشروع الصودا الكاوية وكربونات الصوديوم بالمكس
- التركيبات الكهربائية بالشركة الأهلية للصناعات المعدنية بأبي زعبل
- إنارة شوارع مناطق الإسكان بمحافظة القاهرة
- إنشاء محطات توزيع الكهرباء وكذا شبكات الكابلات بشركتي القاهرة للصباغة والتجهيز ، والنصر لمنتجات الكاوتشوك بشبرا الخيمة
- الأعمال الميكانيكية والكهربائية والمدنية لمحطات الوقود بمختلف أنحاء الجمهورية
- التركيبات الميكانيكية والكهربائية لمصانع شركتي المباني السابقة التجهيز والطوب الرملي

وتفخر الشركة بأنها تقوم بالتركيبات الميكانيكية والكهربائية وأعمال العزل الحراري

لمجمع الحديد والصلب



الغلايات الضخمة بشركة مواد الصباغة والتي قامت الشركة بفكها ونقلها وتركيبها بموقعها الجديد بكفر الدوار

الإدارة العامة ٢٦ شارع عدلي - بالقاهرة
ص.ب ٢٩٧ ت : ٤٨٦٠٠/٤٩٥٠٦/٧٤٣١٥

فرع الإسكندرية :
٢٨ شارع سعد زغلول ت : ٨٠٦٩٦٣

شركة القناة لأعمال الموانى

إحدى شركات هيئة قناة السويس

القاهرة : حى الزهور - مدينة نصر - ت : ٨٣٣٣٠٤ - ٨٣٢٨٦١

أهم أوجه النشاط التى تقوم بها الشركة :

- دراسة وتنفيذ المشروعات الانشائية البحرية .
- عمليات القطر والانقاذ والانتشال البحرى .
- أعمال التطهير .
- الحماية الهندسية للشواطىء .
- أعمال مدنية مختلفة .
- **تنفيذ مشروع ميناء درنة الجديد بالجمهورية العربية الليبية :**

* فى اليوم الثانى عشر من شهر صفر من عام ١٣٩٣ الموافق السابع عشر من شهر مارس ١٩٧٣ تم توقيع التعاقد بين شركة القناة لأعمال الموانى - احدى شركات هيئة قناة السويس - وبين المؤسسة العامة للموانى والمنائر بالجمهورية العربية الليبية ، وذلك عن انشاء ميناء درنة الجديد .

يتكلف المشروع حوالى خمسة ملايين ونصف مليون دينار ليبى .

* يستغرق تنفيذ المشروع مدة ٢٦ شهرا ، وقد بدأ فعلا فى تنفيذ المرحلة الأولى من المشروع فى أول مايو من هذا العام .

* استطاعت شركة القناة لأعمال الموانى الحصول على هذه العملية من بين ثمان شركات عالمية متخصصة فى هذا النوع من الأعمال من بينها شركة ايطالية وشركة ألمانية وشركة مغربية أسبانية وشركة ليبية وشركتان يونانيتان وشركتان يوغوسلافيتان وفى ذلك تأكيد للسمعة الطيبة التى اكتسبتها الشركة فى تنفيذ العمليات المماثلة داخل وخارج جمهورية مصر العربية ، كما انه كسب للخبرة المصرية وتدعيم لكفاءة العمال المصريين .

* من بين الأعمال التى سوف يتضمنها تنفيذ هذا المشروع ، عملية انتشال السفينة « ليدوليتا » والتى كانت قد غرقت فى هذه المنطقة فى عام ١٩٤١ فى أيام الحرب العالمية

* ينتظر أن يكون هذا المشروع انطلاقة لمزيد من العمليات فى جمهورية ليبيا العربية وغيرها من البلاد الأخرى خارج الجمهورية .

الشركة العربية لإستصلاح الأراضى البور

احدى شركات المؤسسة المصرية العامة لإستصلاح الأراضى

النشاط الرئيسى للشركة

أعمال إستصلاح الأراضى

ومشروعات الرى الكبرى

نشاط الشركة فى مجال الاستصلاح

- إستصلاح ٣٣,٠٠٠ فدان بمحافظات : الشرقية ودمياط وكفر الشيخ والبحيرة
- إستصلاح ٦٠٠٠ فدان بمنطقة القصبى «٢» وبركة صان بمحافظة الشرقية
- إستصلاح ٢٩٠٠ فدان بزراعة البستان بمحافظة البحيرة
- إستصلاح ١٠,٠٠٠ فدان بغرب النوبارية بمحافظة البحيرة
- إستصلاح ٢٠٠٠ فدان بالتبين مزرعة الهيئة العامة للمجارى والصرف الصحى

بما فى ذلك الأعمال الترابية والصناعية والتبطين لمجارى الرى والصرف والمحطات من رى وصرف ومبانى القرى بهذه المشروعات .

مشروعات الرى الكبرى

وزارة الرى

- انشاء وحفر ترعة النصر بمكعب ١,٧٥٠,٠٠٠ متر مكعب
- كسر جسور ترعة الاسماعيلية ١,٥٠٠,٠٠٠ متر مكعب
- تعديل وتوسيع ترعة الحاجر - إنشاء ٢ قنطرة حجز ١٠ كبارى مسلحة
- الأعمال الترابية والصناعية والتبطين للرياح الناصرى « المنطقة الرابعة »

٢,١٠٠,٠٠٠ م٣ أعمال ترابية ..
٤١٠,٠٠٠ م٣ أعمال تبطين بالخرسانة
قنطرة حجز ، ٣ كبارى مسلحة على خوازيق حمولة ٧٠ طن - الأعمال الترابية والصناعية بمجارى الرى والصرف لبركة صان الحجر بمكعب ٦٠٠,٠٠٠ م٣ عدد ٥ كبارى و قنطرة فم .

- إنشاء شبكة الصرف المغطى بمساحة ١٠,٠٠٠ ف منطقة الدلنجات بمحافظة البحيرة .

شركة النصر لصناعة الخشب الحبيبي والراتنجات بالمنصورة
ودورها في تدعيم الإقتصاد القومي



ان دخول بلادنا عصر التكنولوجيا الحديثة يعنى ان النظرة العلمية : يجب أن تكون هى نظرة الحاضر والمستقبل . فالعلم يدخل كل يوم مجالات جديدة ، ويحقق يوما بعد يوم نجاحات هائلة . والأن **شركة النصر لصناعة الخشب الحبيبى والراتنجات** بالمنصورة تعى هذه الحقيقة ، فان أنتاجها هو الدليل المؤكد على هذه النظرة .

ففى قطاع صناعة الخشب الحبيبى تنتج الشركة الواح مقاس ١٢٢ × ٢٤٤ سم طبقا للمواصفات العالمية من خامتى سماس الكتان وبشر الخشب ويستعمل فى صناعة الأثاث والمنازل الجاهزة الى جانب الاستعمالات الآتية :

طبالى شدات خرسانية : (بديل اللاتيزانة) مقاس ٦٠ × ٦٠ سم و ٦٠ × ١٢٠ سمك ١٩ مم كثافة ٠.٧٠ احداها مغطاة بالمواد الكيماوية البيتومين وأخرى مغطاة بورق الكرافت المشمع وكانت اللاتيزانة التى تحل محلها طبالى الشدات الخرسانية تستورد من الخارج بالعملات الصعبة وفى هذا المجال تلبى الشركة طلبات شركات المقاولات . والتى ثبت نجاحها من ٦ الى ٨ مرات . وذلك بشهادة الشركات نفسها .

الأبواب : وفيها طورت الشركة انتاجها وركزت على تصنيع أبواب من الخشب الحبيبى المغطى بقشرة موجنة وقوائم موسكى ومقاس الباب ٩٠×٢٢٠سم

الخشب الحبيبى : المغطى بالقشرة الموجنة والحور خصوصا ١٦ مم كثافة ٠.٦٠ المغطى بالقشرة الحور سمك ٢ مم ويصل سمك اللوح بعد تغطيته الى ٢٠ مم .

الصناديق : والشركة تغطى حاجات شركات الغزل والنسيج بصناديق التصدير .

أما فى مجال صناعة الراتنجات فان **شركة النصر لصناعة الخشب الحبيبى والراتنجات بالمنصورة** تنتج :

يوريا فورمالدهيد : (غراء صناعى) وهو يدخل فى صناعة الخشب الحبيبى كما يستخدم فى لصق جميع أنواع القشرة على الأخشاب .

الفينول فورمالدهيد سائل : وهو يستخدم فى صناعة الخشب المضغوط (الهاربورد) .

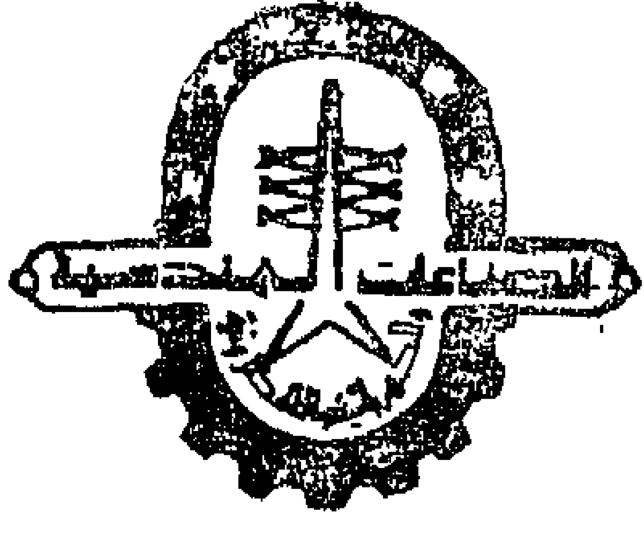
بودرة كبس اليوريا فورمالدهيد : وهى تستخدم فى أغراض متعددة منها صناعة الأطباق والصوانى وصناعة الأدوات الكهربائية وصناعة الزراير وصناعة عدد التليفونات ألوان أبيض وأحمر وأخضر وبنفسجى وغيرها .

وصناعة مقاعد دورات المياه ذات الألوان المختلفة كذلك تدخل فى صناعة ادوات البلاستيك عموما .

بودرة كبس الفينول فورمالدهيد : وتستخدم فى صناعة مقابض أوانى الطهى حيث انها عازلة للحرارة ، وصناعة عدد التليفونات اللون الأسود وفى صناعة الزراير وأدوات الكهرباء وغيرها .

دور الشركة فى خدمة الاقتصاد القومى :

كان من نتيجة تطوير هذه المنتجات **لشركة النصر لصناعة الخشب الحبيبى والراتنجات** بالمنصورة ، أن وفرت أكثر من مليون ونصف مليون جنيه من العملات الصعبة ، كانت تنفق فى استيراد هذه المنتجات . وبذلك استطاعت الشركة أن تؤدى دورها فى خدمة الاقتصاد القومى . بما توفره من عملات صعبة تحتاجها البلاد . وهذه الخطوات الممتازة ، لا يمكن أن تتحقق الا بالجهود الموفقة التى يبذلها العاملون بالشركة وعلى رأسهم المهندس **على عبد الرحمن قداح** رئيس مجلس الادارة .



المؤسسة المصرية العامة للصناعات الهندسية والكهربائية والالكترونية

ودورها الكبير فى خدمة الاقتصاد القومى

اذا كان الانتاج هو المقياس الحقيقى للقدرة الذاتية تعويضا للتخلف واندفاعا للتقدم ومقدرة على مجابهة الصعاب فان قوة اقتصاد أى دولة ترتبط دائما بمدى زيادة صادراتها من المنتجات المحلية والأصناف المعاد تصنيعها .

وبقيام **المؤسسة المصرية العامة للصناعات الهندسية والكهربائية والالكترونية** بدأت نهضة ضخمة وحقيقية فى الانتاج المتطور من سيارات الركوب والأتوبيسات واللوارى والجرارات والمقطورات وعربات السكك الحديدية ومحركات الديزل وبناء السفن والكبارى وصناعة الأوناش والكابلات والدراجات واليايات والفرامل والمراجل البخارية ـ الى جانب المنتجات المعمرة مثل الثلاجات والغسالات الكهربائية المنزلية والطبية واليانيوهات المطلية بالمينا وأفران البوتاجاز والمكوالين والأقفال والخلاطات والبطاريات لجميع الأغراض وأجهزة التكييف والعدد التليفونية والسنترالات والتليفزيونات ولمبات الاضاءة لجميع الأغراض الى جانب عدد كبير من السلع الهندسية والكهربائية والالكترونية الأخرى التى لا تستغنى عنها البلاد وتلقى رواجا لدى الدول العربية والافريقية والأوربية والآسيوية ومما لا شك فيه أن منتجات الصناعات الهندسية من أكثر المنتجات تعقيدا حيث تحتاج الى تطوير متواصل لتتمشى دائما مع أذواق الجماهير فى كل وقت كذلك مسايراتها لمتطلبات العصر والابتكار والاستكشافات والبحوث العلمية وخاصة من كانت طرازاتها سريعة التغيير نتيجة للمنافسة العالمية مثل السيارات والثلاجات والأجهزة المنزلية والكهربائية .

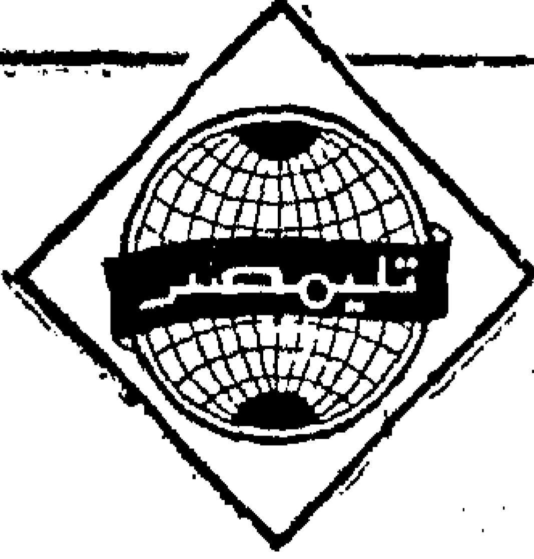
كما ان تصدير المنتجات الهندسية والكهربائية من سيارات وأتوبيسات وثلاجات وغسالات وأدوات منزلية معدنية وراديوهات وتليفزيونات وأجهزة تكييف وخلافه الى الأسواق الخارجية لخير دليل على تقدمها وتطورها رغم المنافسة الشديدة التى تواجهها فى هذه الأسواق .

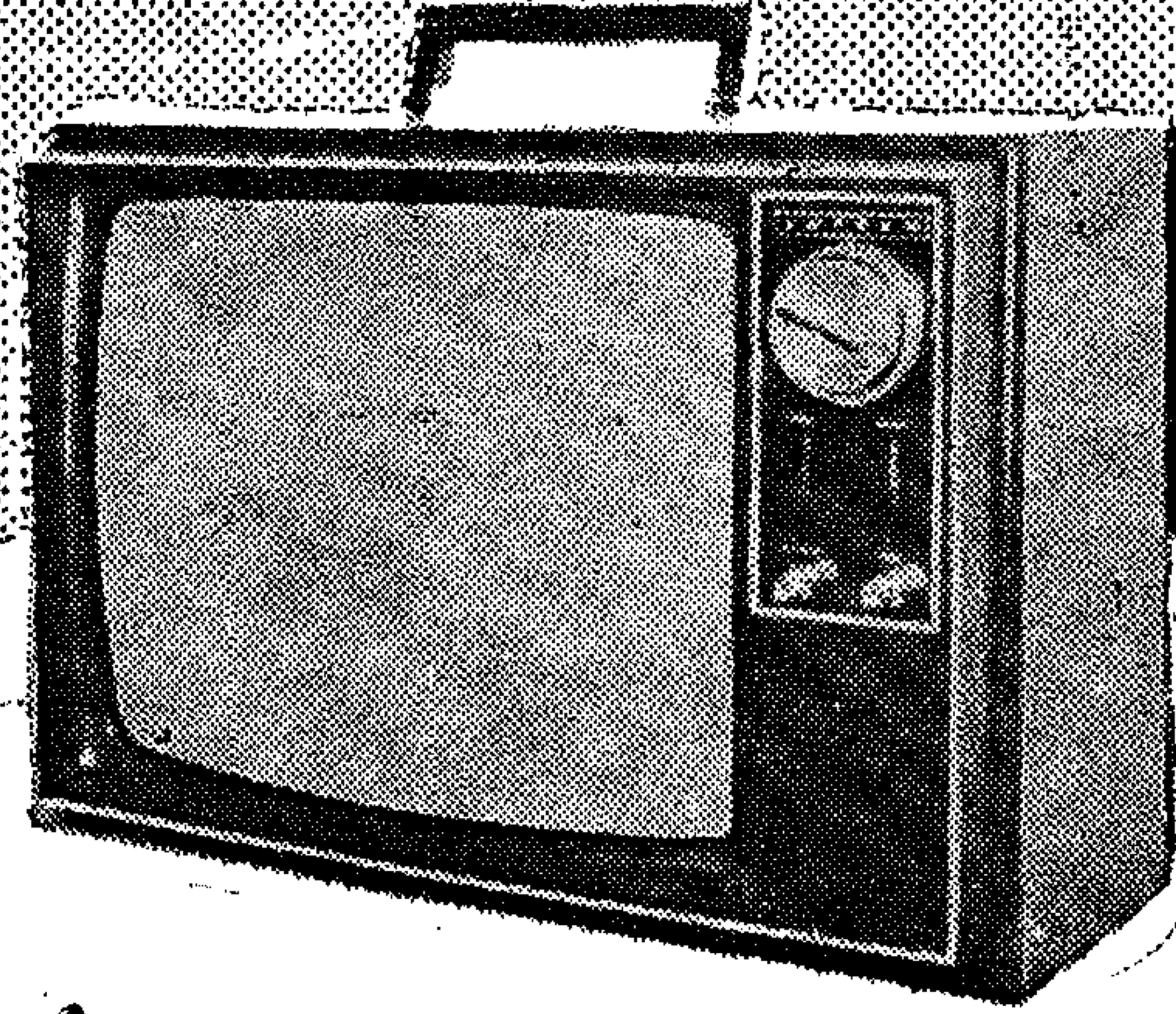
ومما لا شك فيه أن شركات المؤسسة تعتبر فى مجموعها المرآة الحقيقية لتقدم الصناعة فى مصر والدعامة الرئيسية لكيانها الوطنى بما حققته من انجازات ضخمة على امتداد عمر الثورة المصرية كما وانها وهى تخطو الخطوات الواسعة فى الانتاج لم تنسى ان تضع كل فروع صناعاتها الهندسية والكهربائية والالكترونية فى خدمة القوات المسلحة فى المقام الأول محققة توجيهات الرئيس المؤمن القائد **محمد أنور السادات** . مضطلعة بدورها الوطنى فى هذه المرحلة المصيرية لتدعيم الجبهة الداخلية من أجل مساندة اخواننا الرابضين على خطوط النار المتحفزين لتحرير الوطن وتحقيق النصر الكبير باذن الله .

قمة الصناعة العربية الحديثة ... تقدمها :

الشركة العربية للراديو والترانزستور والأجهزة الالكترونية

بانتاجها المتطور بأحدث المواصفات العالمية



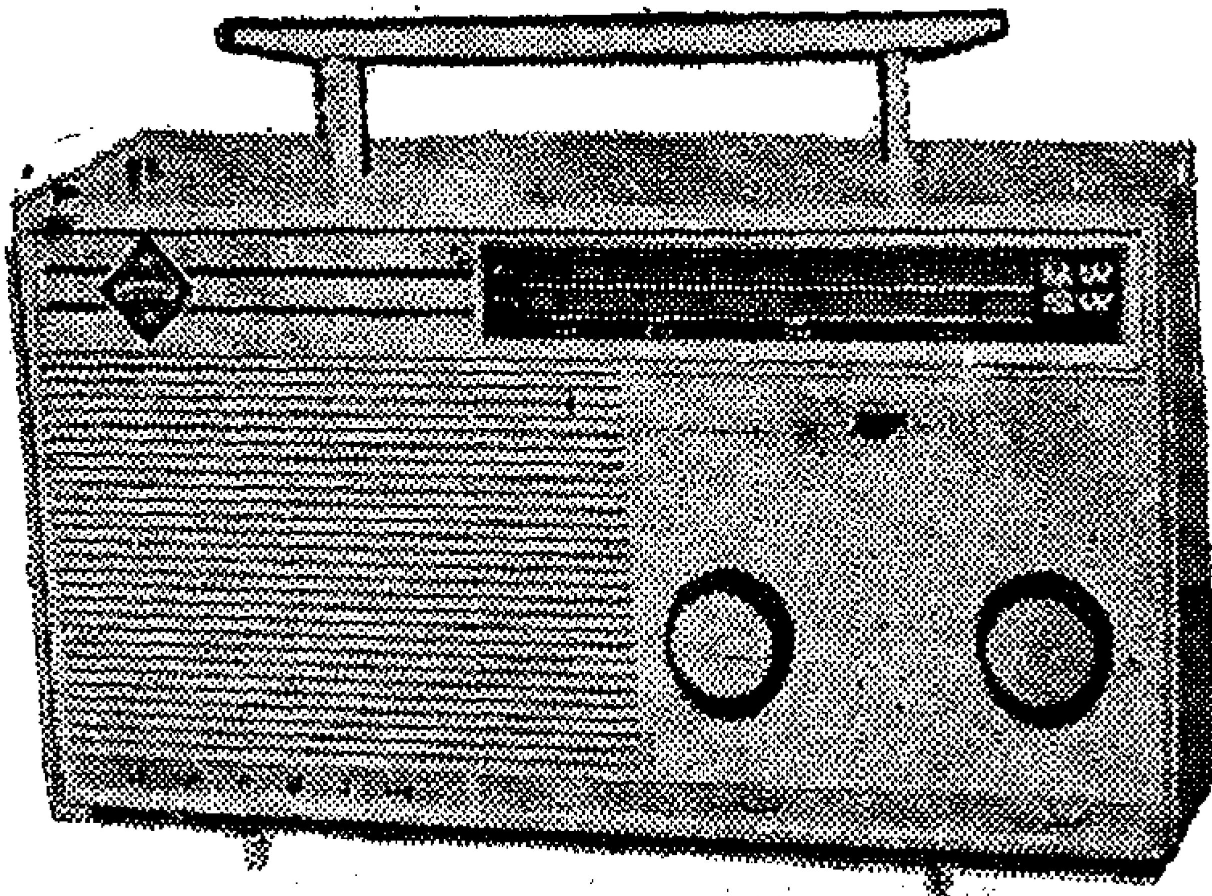


جهاز تليفزيون تليمصر

مقاسات ١٧ ، ٢٠ ، ٢٤ بوصة

راديو ميكو ٧٣

٢ موجة - ٤ حجارة طورش



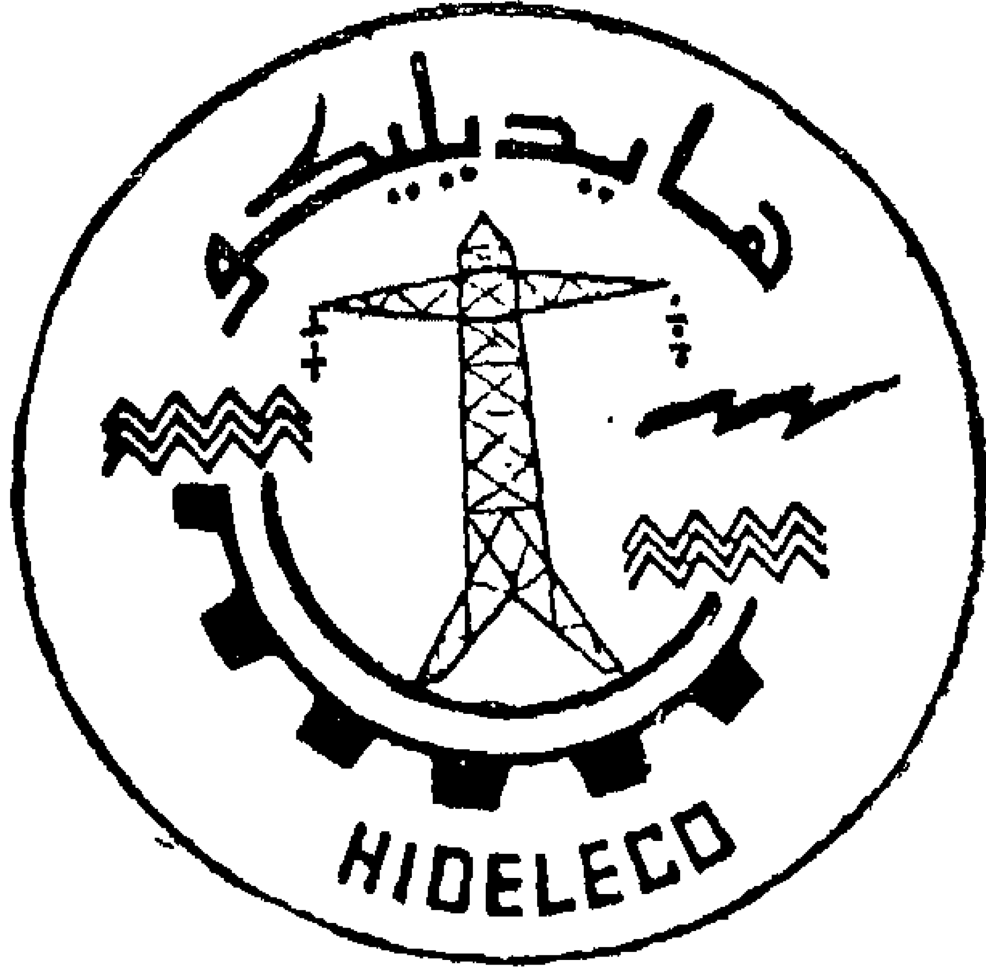
الملفات الخانقة "بالاست"

المواسير البرجمان
مقاسات
١١ ، ١٣ ، ١٦
خفيف وثقيل

مراكز خدمة لصيانة التليفزيون والراديو والنيون

الإدارة والمصانع :
٣ شارع فاطمة رشدى - الطالبية بالهرم - تليفون : ٨٥٠٣٧٩/٨٥٠٣٣٦

هايديليكو بُناة السد يبنون المستقبل

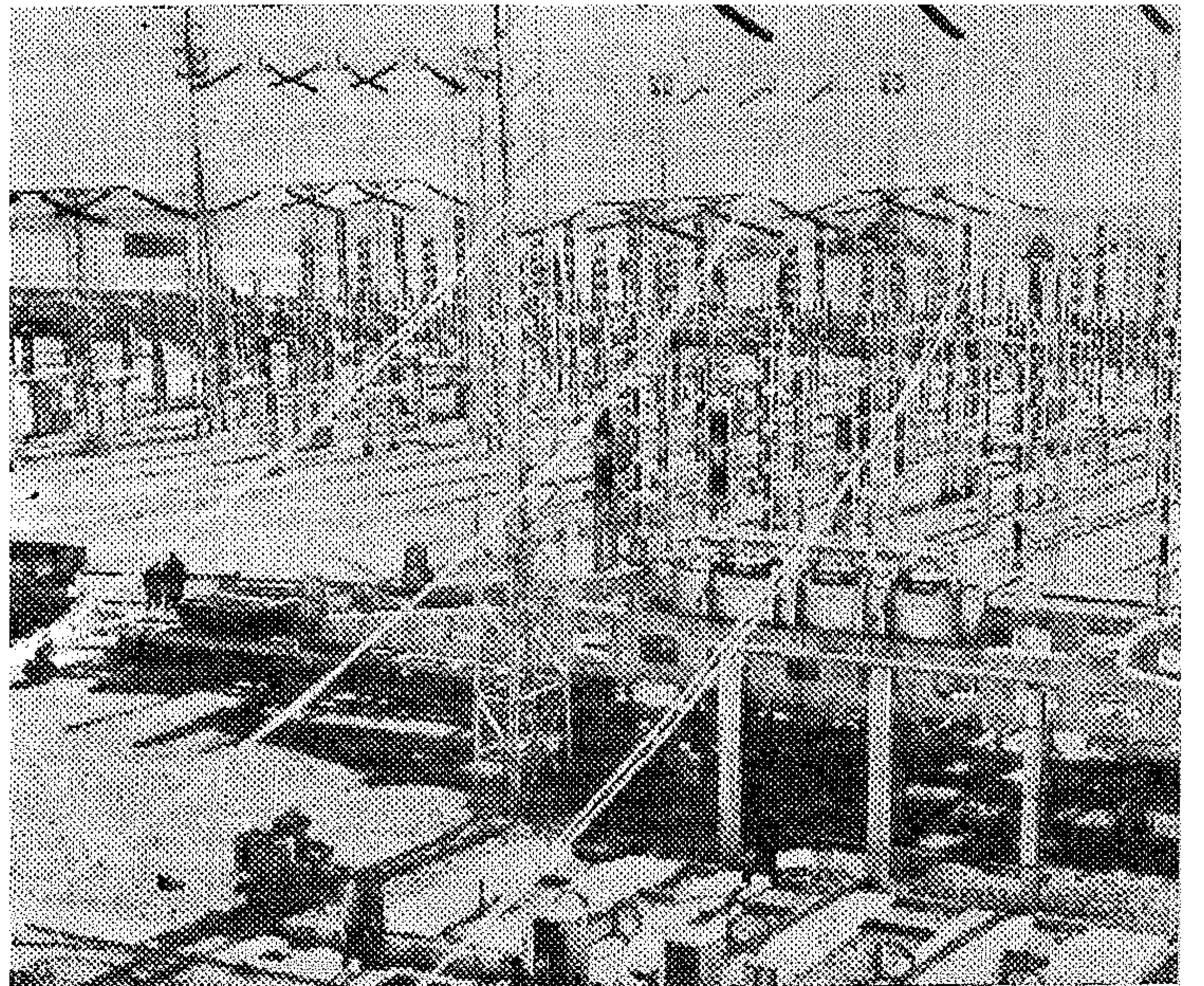


حين تم العمل فى الصرح العظيم التى شادته الارادة الثورية لمصر الحديثة سد أسوان العالى كان الحرص شديدا على الاستفادة من الخبرات الفنية التى تولدت من قيام هذا المشروع الضخم الفريد .

فما الأمم وقدرها الأقدر ما يحتبس بها من طاقات وما يختزن فى عقول أبنائها من خبرات فانصرف الرأى الى الاستفادة بها بتجميعها فى شركات متخصصة تقوم بذات الأعمال التى كانت تتولاها أثناء بناء السد .

وهكذا ظهرت فى منتصف عام ١٩٧١ **شركة السد العالى للمشروعات الكهربائية والصناعية ((هايديليكو))** تجمع بين جنباتها الخبرات التى شادت التركيبات الفنية لمحطات توليد كهرباء السد العالى ومحولات الطاقة وخطوط القوى الكهربائية الضخمة عبر مصر بطولها .

وقد نشأت ((**هايديليكو**)) عملاقة كالعملاق الذى أنجبها بقوة المعدات الوفيرة الضخمة التى آلت اليها من بناء السد العالى وبقوة الخبرات الفنية التى تحويها وبقوة الثقة التى أولتها اياها الدولة ومجمعات الصناعة المصرية .



إنشاء محطات محولات

فلم تكد ((**هايديليكو**)) تتأسس فى ١٩٧١/٧/١ . حتى عهد اليها مجمع الحديد والصلب بتغذية مناجم الحديد بالواحات البحرية بحاجتها من الطاقة الكهربائية من محطات محولات سمالوط عن طريق تشييد خط كهربائى ضغط فائق بطول أكثر من ٢٠٠ كم بالاضافة الى تركيب المعدات الميكانيكية للمناجم ذاتها فنجحت ((**هايديليكو**)) أيما نجاح فى تنفيذ العمليتين فى المواعيد المقررة وعلى خير وجه وبلغت قيمة العمليتين ثلاثة ملايين جنيه ثم عهدت اليها كهربة الريف بكهربة قرى محافظة الغربية والدقهلية وكفر الشيخ ودمياط والفيوم وسوهاج وقنا . وتدعيم الشبكات الكهربائية فى هذه المديريات الست بالاضافة الى تركيب ١٨ محطة محولات كهربائية بالقاهرة والاسكندرية جهد ٦٦ ك.ف. وبلغت قيمة هذا أكثر من مليون جنيه وقد أنجزت الشركة الشطر الأكبر من هذه الأعمال ويجرى تنفيذ باقيتها طبقا للبرامج الموضوعة لهذا الغرض .

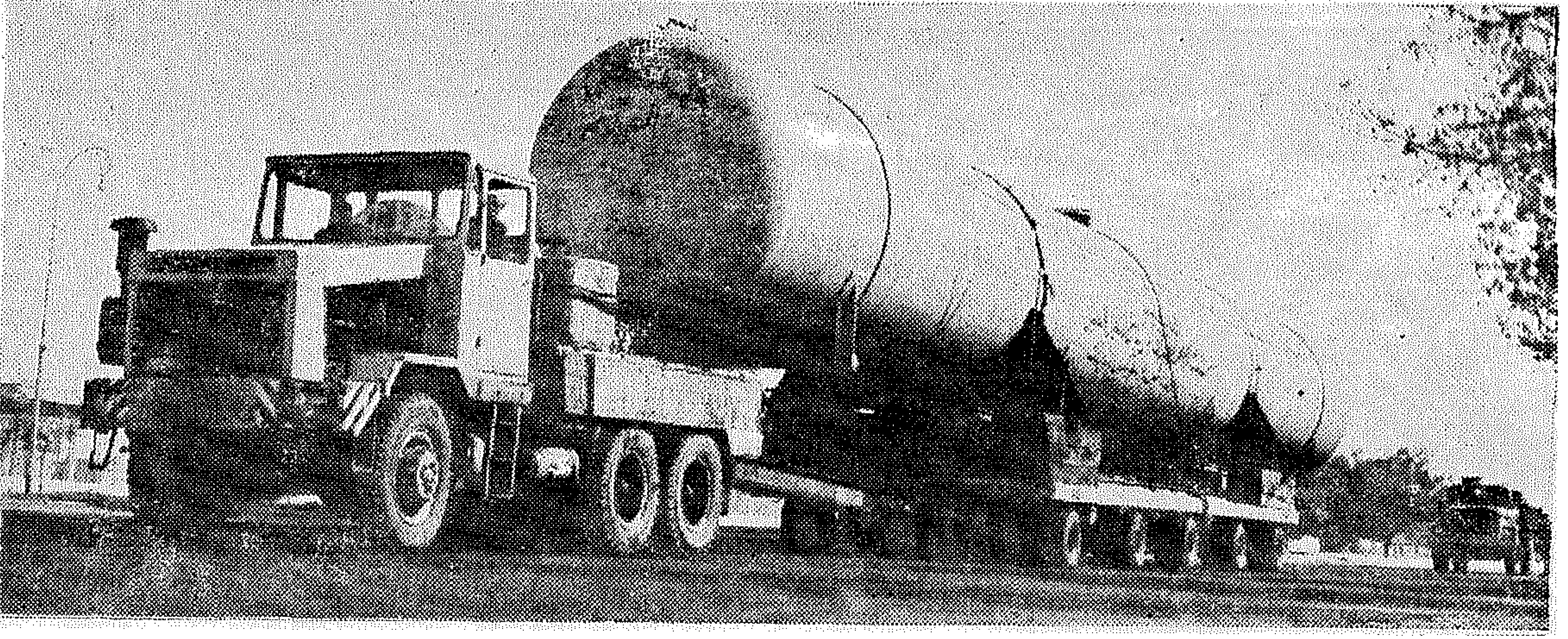
وكان من حظ ((**هايديليكو**)) أن عهد اليها بحماية البيئة الحيوية فى حلوان من التلوث فأسند اليها تركيب المرشحات الالكتروستاتيكية لأفران مصانع شركة أسمنت بورتلاند وقد أوشكت ((**هايديليكو**)) على الانتهاء من هذه العملية التى تزيد تكاليفها عن ربع مليون جنيه ومن المنتظر أن تظهر قريبا نتائجها الرائعة فى حماية البيئة الطبيعية والصحية للعاملين بهذه المنطقة الصناعية .

وبعد أن لمس مجمع الحديد والصلب فاعلية مجهودات ((**هايديليكو**)) وانجازاتها الفنية أسند اليها فى العام الماضى التركيبات الميكانيكية لمحاجر بنى خالد والتركيبات الكهربائية لمستعمرته السكنية بحلوان وهى أعمال تزيد قيمتها على مليون جنيه .

ولم تكن ((**هايديليكو**)) لتقابل هذه الثقة الكبرى من كافة قطاعات النشاط فى مصر الا بتطوير أجهزتها وأنظمتها لتكون على مستوى مسئولياتها .

أخذت ((**هايديليكو**)) فى تعزيز معداتها الضخمة بشراء أحدث المعدات الفنية وبالعملة الصعبة وكذلك تطوير أنظمتها المالية والادارية والمخزنية وفق أحدث الأساليب العلمية وتولت تربية شبابها الهندسى فى مضمار المسئولية الفعلية ليستوعب الجيل الصاعد خبرة الجيل الرائد .

ولم تكن ((**هايديليكو**)) لتضمن بهذه الخبرة على وطنها الأكبر فأوكلت لها ممثلين فى جميع الدول العربية يشاركون فى مشروعاتها الصناعية والتقدم عنها بعطاءات بلغ اجمالها أكثر من ١٠٠ مليون جنيه.



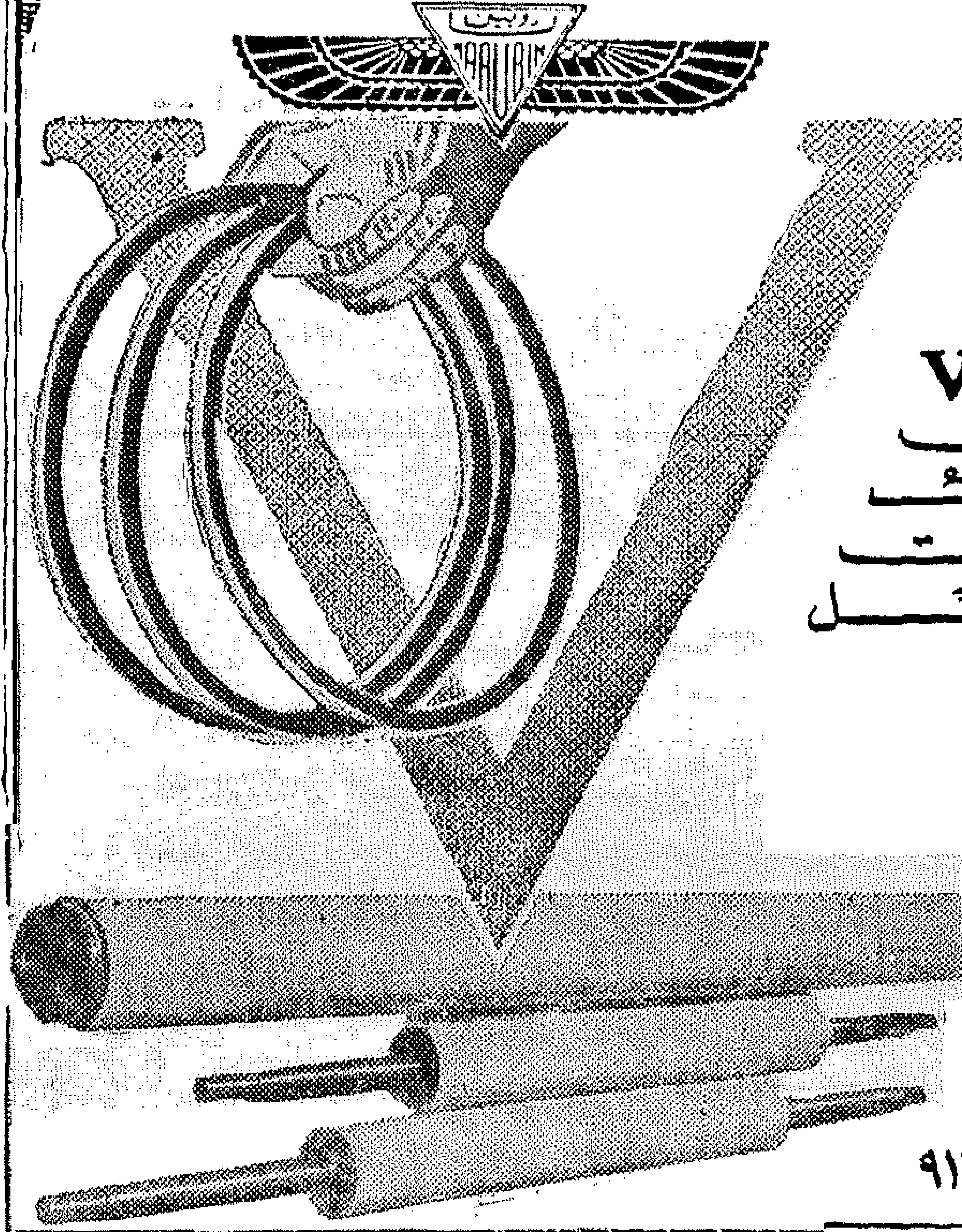
أكبر أسطول للنقل الثقيل بالشرق الأوسط

ومن قبل أن يعبر رجال مصر البواسل ضفتها الشرقية ليرفعوا هامة الانسان المصرى وليردوا اعتبار الانسان العربى . عبر بناة السد العالى رجال ((هايديليكو)) تخومها الغربية ليعينوا مؤسسة كهرباء ليبيا الشقيقة فى مشروعاتها الكبرى لتوزيع الكهرباء على ربوعها فأقامت المحولات الكبرى وخطوط الكهرباء ذات الجهد الفائق فى مناطق العيجلات وطبرق وبنغازى وفزان بطول يقرب من الف كيلو متر بمبلغ يزيد على ١٠ مليون جنيه ليبى .

أعمال التركيبات الصناعية لمناجم الواحات البحرية لمجمع الحديد والصلب

شركة النصر لمنتجات الكاوتشوك

«ناروبين»



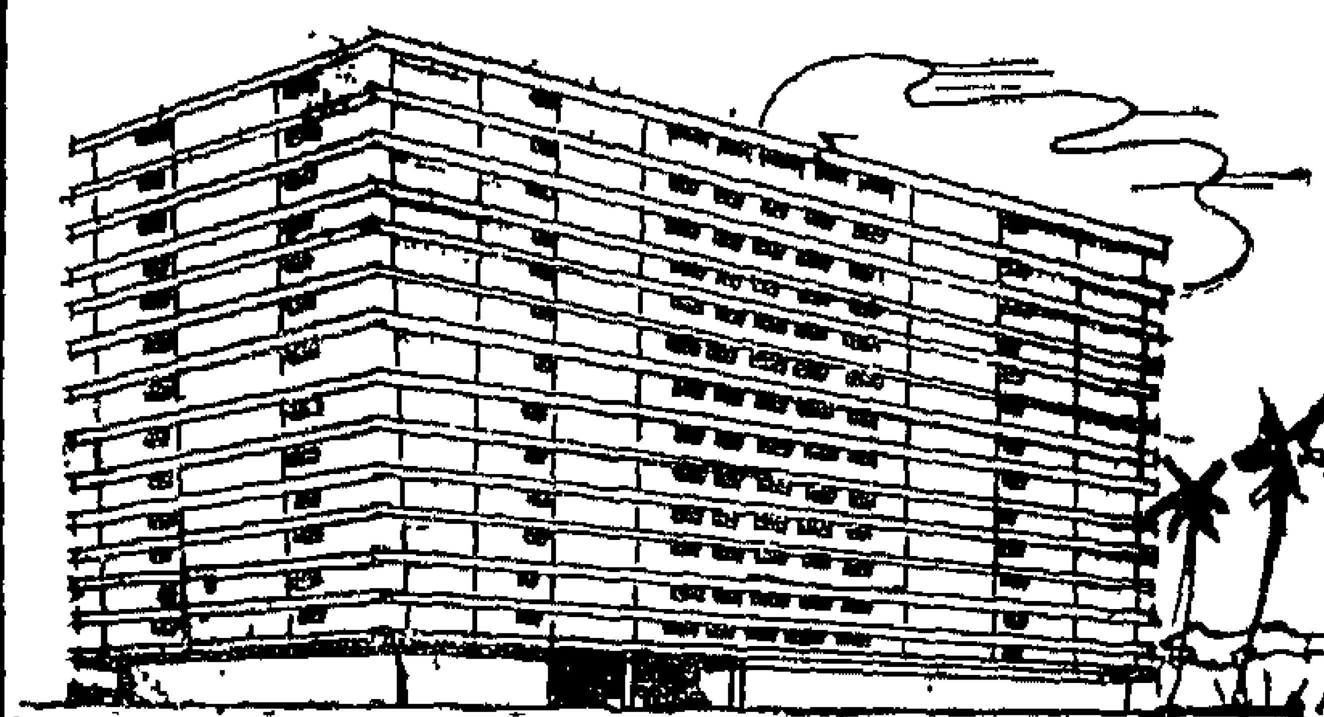
تقدم منتجاتها ذات الكفاءة العالية لجميع الإستخدامات
لقطاع الصناعة

- سيور حرف V
- سيور حركة ونقالى
- قطع غيار كاوتشوك
- خراطيم من جميع المقاسات
- تكسية الدرافيل



إدارة البيع :

القاهرة : ٢٢ شارع سليمان الحلبى
« دوبريه سابقاً »
تليفون : ٩١١٧٢٢ - ٩١١٩١٥



شركة القاهرة للإسكان والتعمير

إحدى شركات المؤسسة المصرية العامة للإسكان والتعمير

- مساكن لجميع المستويات
- تقسيم أراضى وتزويدها بالمرافق
- إدارة وتقسيم أراضى الغير

إسكان حاليًا :

- شقق بعمارة برج الأورمان بالجيزة
- شقق بشارع ابن زنكى بالزمالك
- شقق بشارع إسماعيل أبو الفتوح بالدقى
- مكاتب بعمارة رمسيس بشارع رمسيس

تعمير حاليًا :

- مشروع تقسيم أرض ستاهى بالإسكندرية
- « « أرض الفضالى بالراحة السوداء
- « « مدينة السادات بطريق مصر - إسكندرية الصحراوى

المركز الرئيسى : القاهرة ١٩ شارع عبد السلام عارف تليفون : ٢٢٢٤٧ - ٣٢٠٢٥

مؤسسة النقل النهرى

تقيم أضخم مشروعات الثورة فى مجال النقل النهرى
وأول مركز تدريب إقليمى للنقل النهرى بالشرق

النقل النهرى من أهم الوسائل التى تبرز فى مجال دعم الحركة الاقتصادية والصناعية لرخصه وحجم كفاءته ولقد توفرت لبلادنا الظروف الطبيعية التى تتيح لها شرايين مائية تصل بين مختلف أنحاء البلاد من أسوان الى الاسكندرية فكان لابد من النهوض بمرفق النقل النهرى ليكون قادرا على مواجهة احتياجات التقدم ، ولهذا انشئت (**المؤسسة المصرية العامة للنقل النهرى**) لتحمل مسئولية النهوض بهذا المرفق الحيوى الهام .

ومن أجل ذلك اهتمت المؤسسة اهتماما كبيرا بتطوير الطرق الملاحية المختلفة لتكون قادرة على تحمل وحدات النقل الحديثة واستيعابها دون تعطل .. وتقوم المؤسسة بتنفيذ العديد من المشروعات الضخمة ومنها فى هذا المجال :

* تنفيذ مشروع تحويل ترعة النوبارية الى قناة ملاحية من الدرجة الاولى .

وبذلك تصبح هذه القناة من أهم الطرق المائية التى تربط القاهرة بميناء الاسكندرية لتكون الحركة متصلة بين الميناء وأبرز ما فى هذا التطوير هو أنه سيتيح للوحدات المائية الحديثة أن تقطع المسافة بين القاهرة والاسكندرية فى ثلاثة أيام فقط بدلا من عشرة أيام علاوة على امكان تشغيلها طول أيام السنة بنفس الكفاءة .

وقد روعى فى هذا التطوير تزويد الطريق النهرى بعلامات ارشاد ملاحية لخدمة حركة الملاحة ليلا ونهارا . ويخدم هذا المشروع كافة عمليات البناء الصناعى فى الجمهورية وخاصة مشروع مجمع الحديد والصلب ـ الى جانب دور هذه القناة فى رفع كفاءة النقل النهرى وزيادة مشاركته فى حركة النقل فى البلاد ـ مما يدفع عجلة التطور بسرعة الى الامام ، ومنذ أيام شهد **المهندس الحسينى عبد اللطيف** وزير النقل وبرفقته **المهندس توفيق خفاجى** مدير عام المؤسسة التجارب النهائية لتشغيل هويس المالح وهو اكبر مشروعات تحويل ترعة النوبارية الى ترعة ملاحية من الدرجة الاولى وتبلغ تكاليفه وحده الاجمالية حوالى ٥ر٣ مليون جنيه ، وقد صمم الهويس بحيث يسمح بنقل ما يزيد عن ١٥ مليون طن سنويا من البحر الابيض واليه .

ولكى يتم تشييد هويس المالح أقيم سد حافظ لمياه البحر اثناء التنفيذ بلغت مكعباته حوالى ٣٠ ألف متر مكعب وتم دق ٥٢٥ ستارة بطول حوالى ١٢ متر ، كما أن مكعبات انشائه بلغت ١٣٠ ألف متر مكعب حفر صخور ، ٣٠ الف متر مكعب خرسانة مسلحة وعادية ، ١٠٠٠ متر مكعب مبانى من حجر الجرانيت ، ٢٠٠٠ متر مكعب مبانى من حجر البازلت ، وستدار البوابات بالكهرباء وبلغت تكاليف انشائها وعلامات الارشاد والشاشة التليفزيونية حوالى ١/٢ مليون جنيه .

ويعتبر مشروع ترعة النوبارية أضخم مشروعات الثورة ويمكن بحق أن يقال عنه أنه قناة السويس الثانية ولايضاح ضخامة مشروع ترعة النوبارية ، نوضح أنه قد أقيم عليها ٧ أهوسة مقاس ١١٦ × ١٦ متر وأربع كبارى علوية للسكك الحديدية وثمانية عشر كوبرى علوى للطرق وسحارة لصرف مياه مصرف القموم تمر من تحت الوصلة الملاحية لترعة النوبارية وتبلغ تكاليف انشاء هذا المشروع العظيم حوالى ٢٥ مليون من الجنيهات ، وقد صمم ونفذ المشروع بأجمعه بأيد مصرية .

ومن أجل رفع مستوى العاملين بالنقل النهرى واعداد عمالة جديدة مثقفة بالوحدات النهرية وبناء السفن .

قام **المهندس الحسينى عبد اللطيف** وزير النقل **والمهندس جعفر محمد عبد الله** رئيس المؤسسة بوضع حجر الاساس لمبنى مركز التدريب الاقليمى للنقل النهرى .. الذى سيحقق نهضة علمية حديثة فى مجال النقل النهرى لجميع المستويات ومختلف

التخصصات ـ الى جانب دراسات عليا للمهندسين والماليين والاداريين فى النواحى المتصلة بعملهم ، كما سيفتح المركز أبوابه لمبعوثى الدول العربية .. والافريقية .. وتكلف مليون جنيه مصرى بالاضافة الى حوالى ٤٠٠ ألف دولار تدفعها هيئة برامج التنمية بالامم المتحدة وتمثل قيمة المعدات والاجهزة العلمية الحديثة وتكاليف المبعوثين المصريين للخارج الذين سيقومون بالتدريب فى المركز وتكاليف الخبراء المعاونين من الامم المتحدة .

وسيقام هذا المركز الذى يعد الاول من نوعه فى الشرق الاوسط على مساحة ٢٠ ألف متر مربع ويتكون من ثلاث منشآت رئيسية .. وحمام سباحة لتدريب البحارة مساحته ١٨٠٠ متر مربع ويتكلف نحو نصف مليون جنيه .. وقد صممت صالة المحاضرات وجهزت بسقف عرض ٢٤ مترا بدون أعمدة ومن نوع جديد يستعمل لاول مرة فى الشرق وسيتم اقامة المركز خلال عام واحد .

هذه بعض انجازات **المؤسسة المصرية العامة للنقل النهرى** والوجه المشرق لمصرنا العزيزة بذلا وتعاونا على طريق النصر بقيادة الرئيس المؤمن **محمد أنور السادات** .

CANAL HARBOUR WORKS CO.

SUEZ CANAL AUTHORITY

CABLE Address : HARVAGE

HEAD OFFICE : Ismailia — U.A.R.
Telephone 2811 (S.C.A)

CAIRO : El Zouhour District
Nasr City Tel. 83304
832861

ALEXANDRIA : 33, Salah Salem Street
Telephone 804633

The Canal Harbour Works Co., which is affiliated to the Suez Canal Authority was founded in 1965 with a capital of two million Egyptian pounds, to fill in a long existing gap in the field of erection of harbours, protection of shores and salvage and towage of ships.

This field was monopolised in the past by foreign foundations. The Canal Harbour Works Co. has since replaced these foundations. When. as a result of the Israeli aggression in the Suez Canal, the navigation in the water way was interrupted, The Canal Harbour Works Co. transferred a part of its activities to other countries with the intention of opening new international fields of action and naturally increasing the national income in foreign currency.

In spite of the competition of other specialized companies, the Canal Harbour Works Co. succeeded in signing contracts for the execution of important works in Syria for the amount of thirty two million Syrian liras. The company is now executing projects which are of vital importance for the Lybian Arab Republic for the amount of about fiive millions and half Lybian Dinars. (Coustructions of the new Derna Harbour).

For the execution of these works, the Company has provided Syria and Lybia with the necessary equipment and adequate machinery, as well as the necessary experienced stff.

الخامات الاولية
والصناعات الكيميائية

**جمعية مهندسي المناجم والبترول
والفلزات
جمعية المهندسين الكيميائيين**

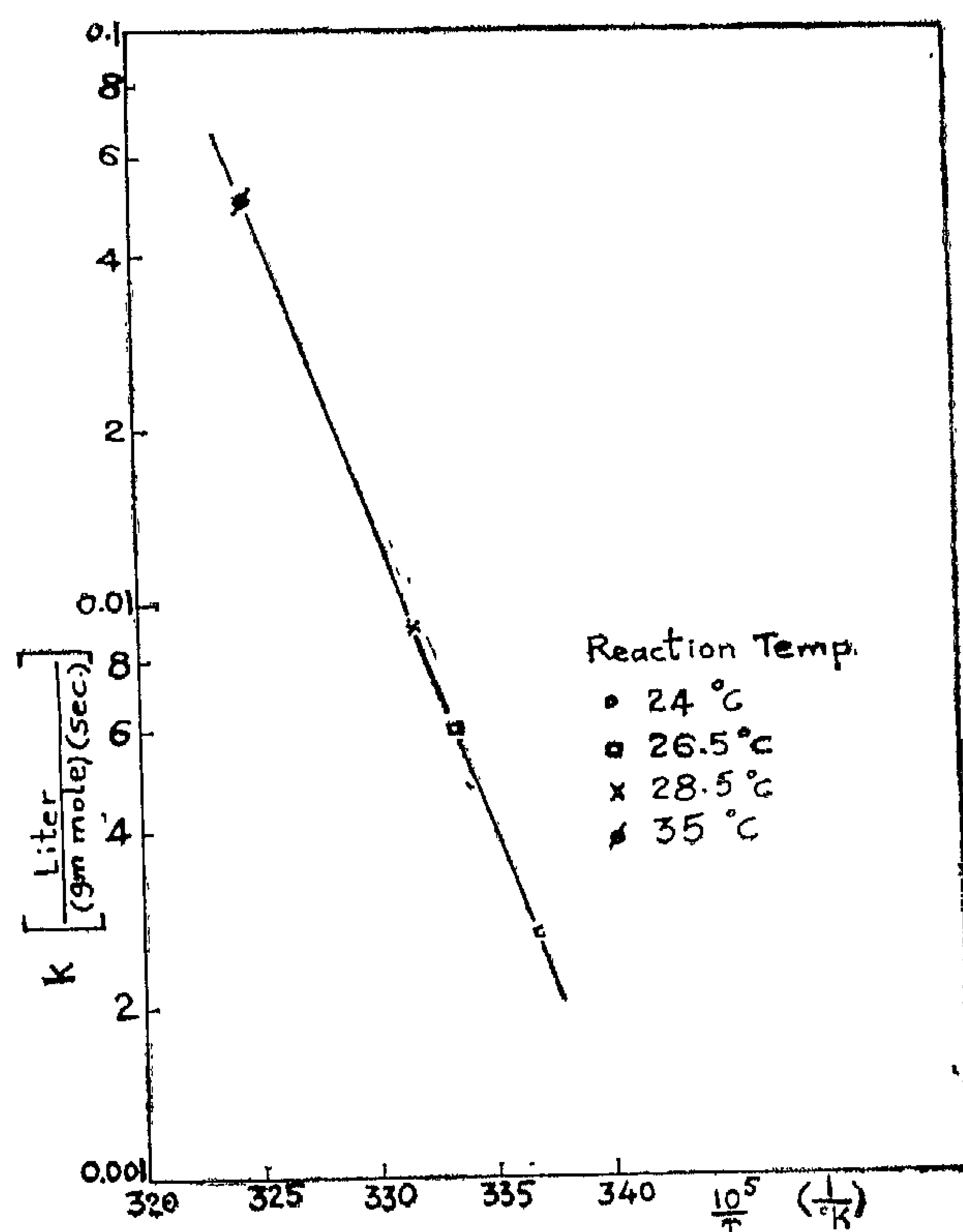


FIG.(6) Variation Of Reation Rate Constant With Temperature

is not affected on increasing the stirrer speeds from 100 to 300 r.p.m. However, much higher speeds result in complete instantaneous conversion indicating a very high frequency factor and conversion rate. The value of the frequency factor at stirrer speeds of 100 — 300 r.p.m. equals $6.\ (10)^{34}\ \frac{\text{liter}}{(\text{gm mole})\ (\text{sec.})}$ and the predicted reaction rate equation is,

$$\frac{dc}{d\theta} = 6\ (10)^{34} \cdot e^{\frac{-25,576}{T}} \cdot C^2 \quad \frac{\text{gm mole}}{\text{liter (sec)}}$$

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Table (1)

Variation of Reaction Rate Constant with Temperature

Temp., (°K)	K $\left(\frac{\text{gm } H_3PO_4}{\text{gm total phase}}\right)^{-1} \text{min}^{-1}$	K $\left(\frac{\text{gm mole } H_3PO_4}{\text{liter}}\right)^{-1} \text{sec}^{-1}$
297.0	1.8	0.00268
299.5	4.2	0.00595
301.5	6.6	0.009
308.0	36.7	0.05

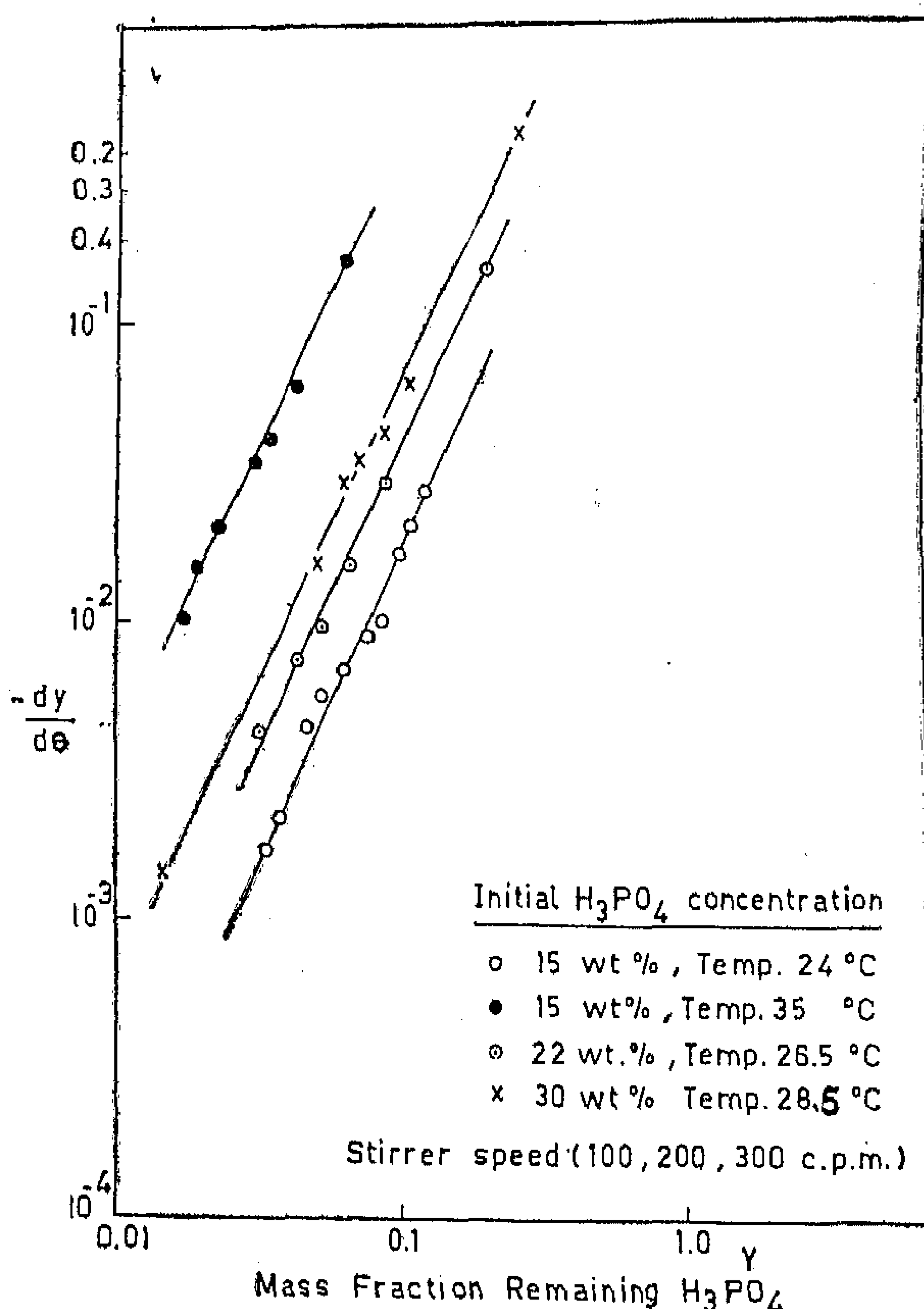


FIG. (5) Variation of Reaction Rate with H_3PO_4 Concentration and Temperature.

Values of k were then plotted against 1/T on semi-log paper as shown in figure (6). A straight line was obtained between the plotted points. The equation of the line is,

$$k = 6 \times (10)^{34} \; e^{-\frac{25,576}{T}} \; \left(\frac{(\text{gm mole } H_3PO_4)^{-1}}{\text{liter}} \; \text{sec}^{-1} \right) \quad (4)$$

The activation energy is estimated as,

E = 25,576 (1.987) = 50,820 (cal./gm mole)

The final expression for the rate equation at stirrer rotation speeds of 100, 200, 300 r.p.m. is,

$$\frac{dc}{d\theta} = 6(10)^{34} \, e^{-\frac{25,576}{T}} \; {}^{2} \left(\frac{\text{gm mole } H_3PO_4 \text{ removed}}{\text{liter sec}} \right)$$

where,

C = Concentration of H_3PO_4 in gm mole/liter.

CONCLUSION

The reaction between urea and phosphoric acid in the homogeneous aqueous phase is a very fast second order reaction. The reaction rate is very sensitive to temperature and the reaction rate constant increases with higher temperatures. The activation energy was evaluated as 50,820 cal./gm mole. The reaction rate constant

(2.3) **Prediction of the Reaction Order:**

In order to evaluate the reaction order, the experimental data was converted into mass fraction remaining H_3PO_4, y, as represented by the equation,

$$y = \frac{(1-x)w_a}{100+w_u}$$

where,

Y = mass fraction remaining H_3PO_4 $\frac{\text{gm } H_3PO_4}{\text{gm total phase}}$

X = mass fraction converted H_3PO_4.

W_a = weight of acid initially present per 100 gms H_3PO_4 aqueous solution.

W_u = weight of urea initially present in the reaction mixture.

Calculated values of y are shown plotted in figure (4) versus the time θ from which it is observed that the rate of decrease of y with respect to time is greater at higher acid concentrations and reaction temperatures. The experimental results were then analysed applying the differential method by calculating Δy, $\Delta\theta$ for equal interbals of $\Delta\theta$ and then plotting $\Delta y/\Delta\theta$ against the average y on log-log coordinates as shown in figure (5). The plotted points for different concentrations and reaction temperatures fall on parallel straight lines having a slope of two. This establishes the rate equation as,

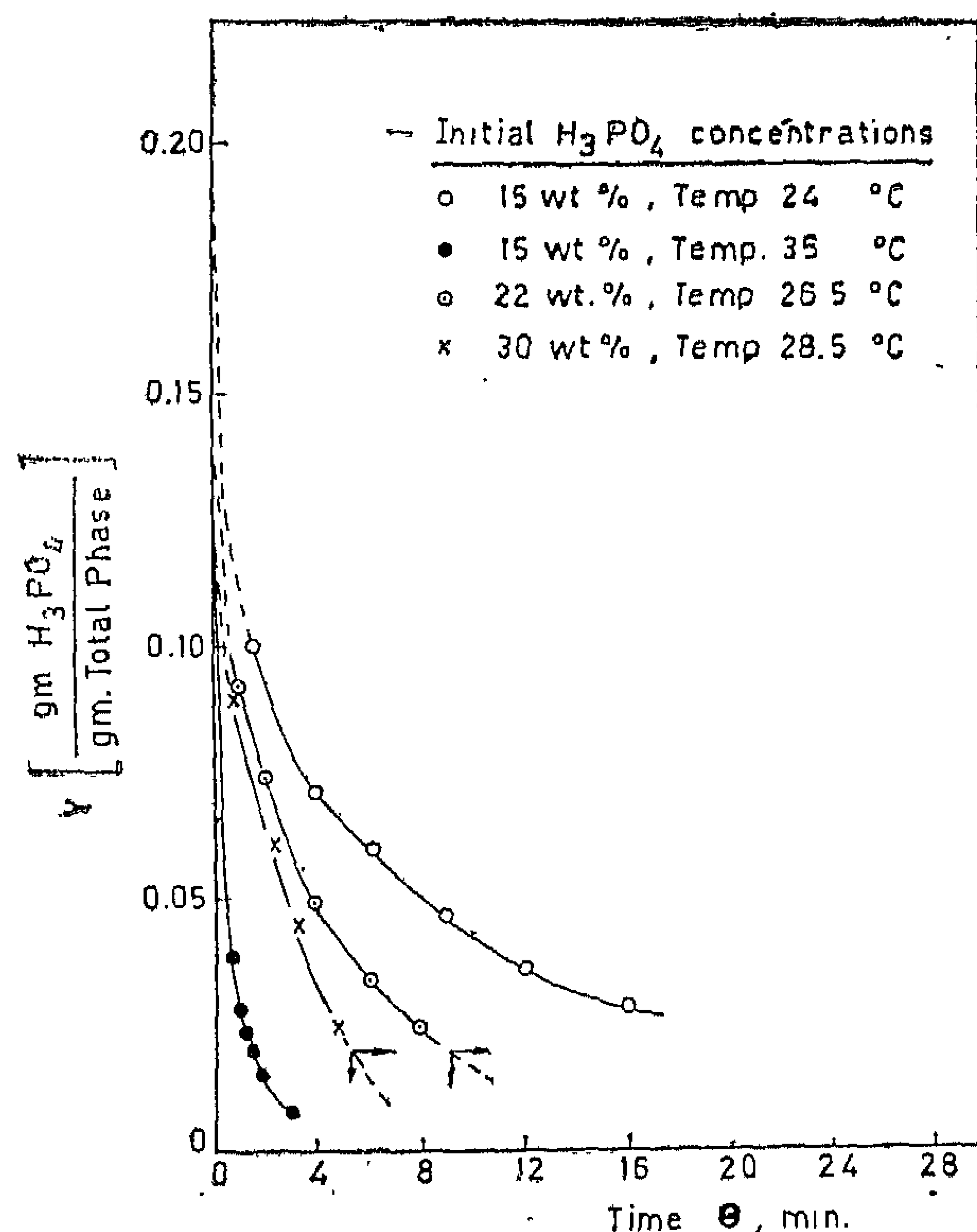


FIG. (4) Variation of Mass Fraction H_3PO_4 with Time of Reaction.

$$-\frac{dy}{d\theta} = ky^2 \quad \left(\frac{\text{gms } H_3PO_4}{(\text{min})(\text{gm total phase})}\right) \quad (2)$$

which means that the reaction is second order. Equation (2) also establishes the relation between the reaction rate and concentration. The increase in the reaction rate constant k is a result of higher reaction temperatures.

(2.4) **Analysis and Correlation of the Reaction Rate Constant :**

The reaction rate constant k is a function of other factors controlling the reaction rate than the concentration. It has been seen from the previous item to be dependent on the reaction temperature. Arhenius equation (3) was then applied to predict the relation between k and the absolute reaction temperature T (°K),

$$k = k_o e^{\frac{-E}{RT}} \quad \ldots\ldots\ldots (3)$$

where,

k = Frequency factor

E = Activation energy, cal./gm mole.

R = Universal gas constant 1.987 $\frac{\text{cal.}}{\text{gm mole °K}}$

T = Absolute reaction temperature (°K)

The following table gives the values of k corresponding to different reaction temperatures as obtained from figure (5).

value of the reaction mixture was recorded at small intervals of time. Reaction mixtures containing different initial acid concentrations of 15, 22, 30 wt % H_3PO_4 on urea free basis were used. The temperature of the reaction mixture was recorded to study its effect on the reaction rate. The effect of the degree of mixing was studied applying different speeds of rotation for the stirrer of 100, 200, 300 r.p.m. as well as much higher speeds.

2. Experimental Results and Discussion

(2.1) Effects of initial H_3PO_4 Concentration and Reaction Temperature:

The recorded pH value of the reaction mixture at consecutive small intervals of time are plotted in figure (2) for the three different initial H_3PO_4 concentrations at a stirrer speed of 100 r.p.m. The corresponding calibration charts were then used to determine the percentage conversion corresponding to the measured pH values.

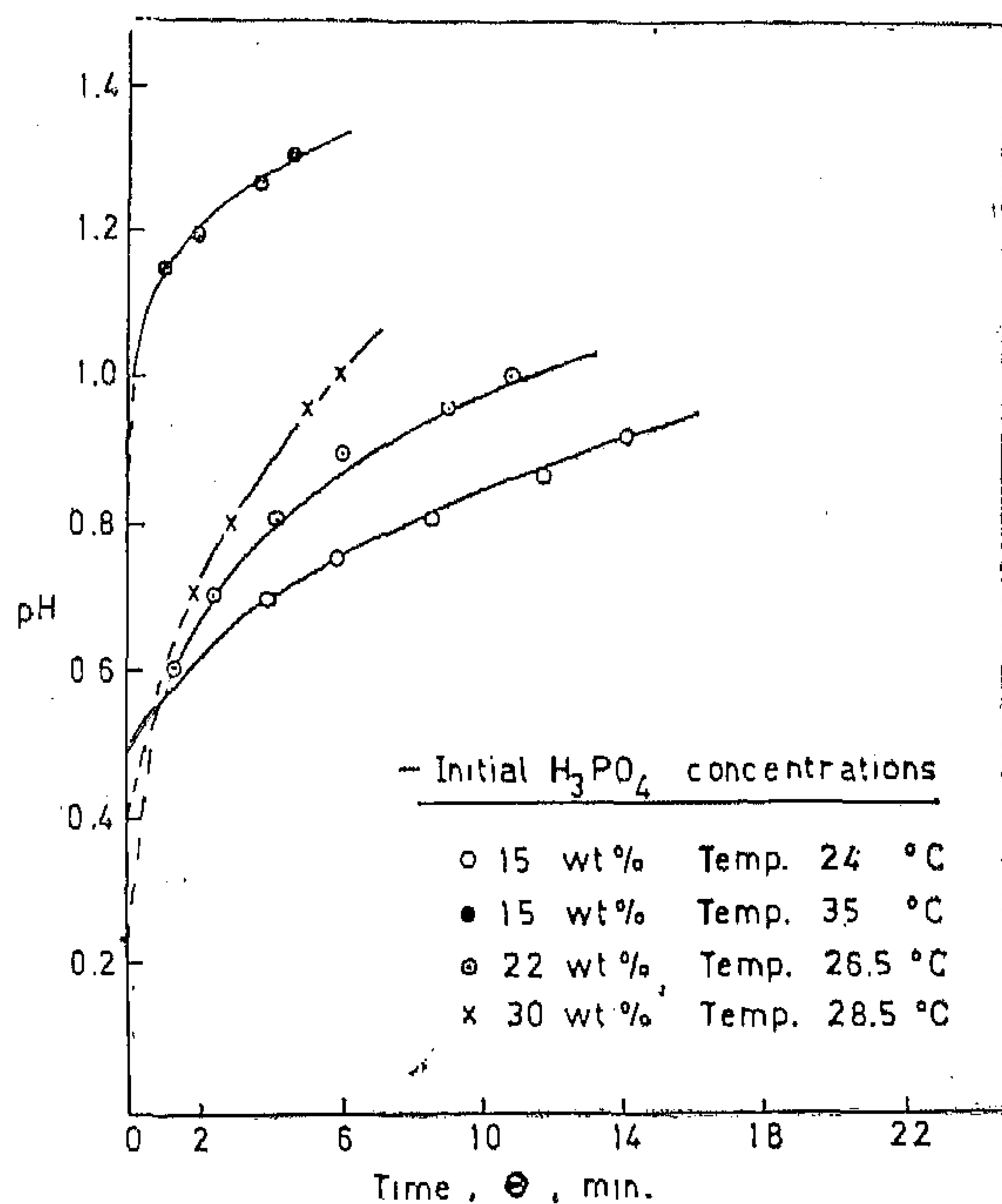


FIG. (2) Variation of pH Value of Reaction Mixtures with Time.

Figure (3) illustrates the variation of the percentage conversion with time. It is observed that initial higher concentrations of H_3PO_4 associated with higher reaction temperatures result in a higher percentage conversion after the same period of interaction. The increase in the rate of conversion is a result of both increased concentration and reaction temperature. Comparing the curves for solutions of 15 wt % H_3PO_4 initial concentration establishes the effect of temperature on the conversion rate.

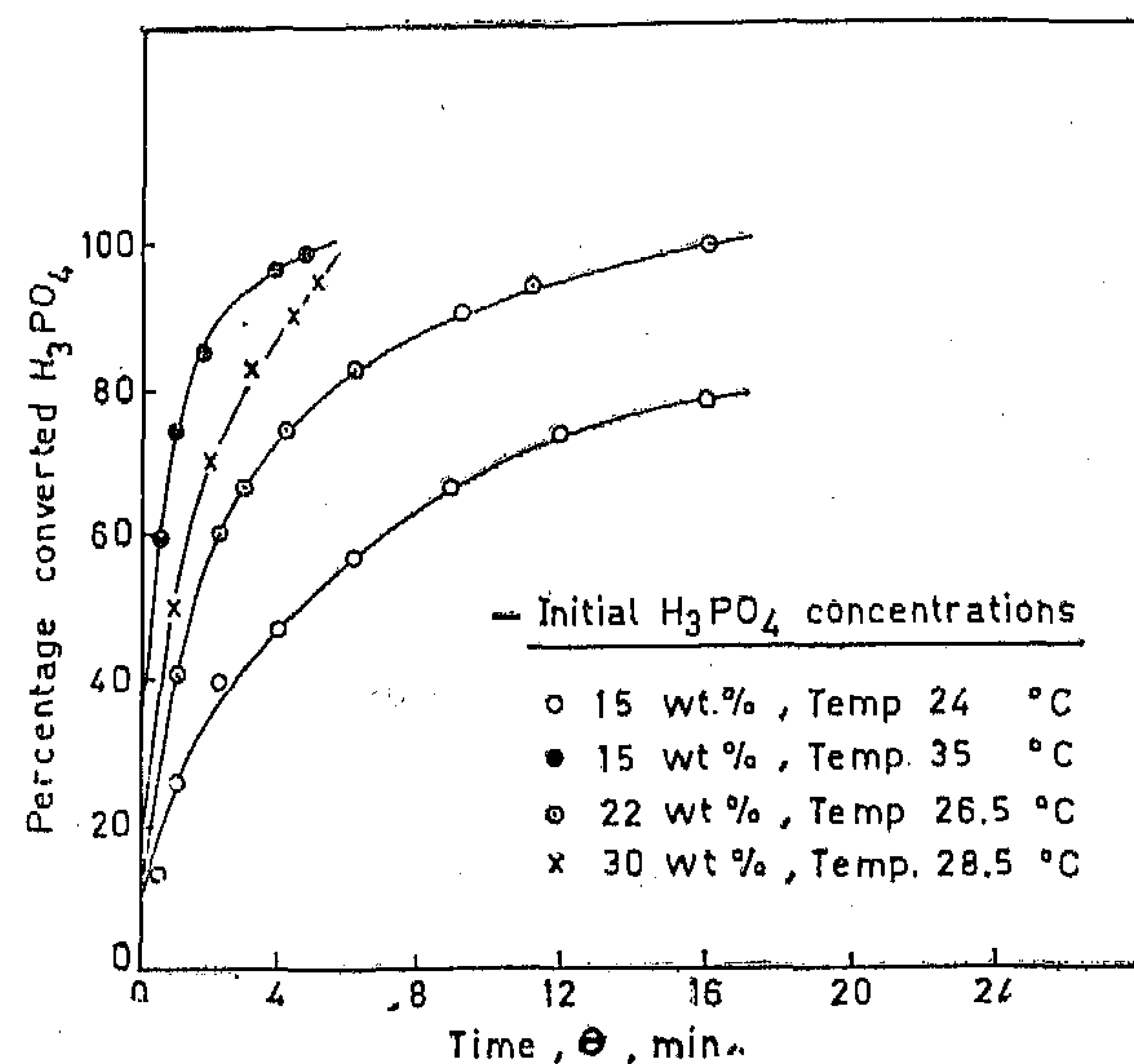


FIG. (3) Variation of the % age Converted H_3PO_4 with Time of Reaction.

(2.2) Effect of the Degree of Mixing:

In order to study the effect of the degree of agitation on the reaction rate, the experimental work mentioned in the previous item was repeated applying speeds of rotation of 100, 200, 300 r.p.m. for the stirrer in the reaction vessel. It was observed that the same results were reproduced indicating no effect of the speed of rotation within the specified limits on the reaction rate. However, much higher speeds of rotation resulted in almost complete instantaneous conversion and it was not possible to record the pH value of the reaction mixture at small intervals of time.



(c) Beckman and Radio pH meters available in the National Research Centre at Cairo were used in this investigation. The memeters are provided with mixing beakers fitted with variable speed stirrers.

(1.2) Method of Determination of the Percentage Conversion of Phosphoric Acid into Urea Phosphate:

As the addition compound urea phosphate is acidic it was not possible to determine its quantity in an aqueous solution containing also H_3PO_4 by titration methods. Also the phosphomolybdate method is not suitable to evaluate each of H_3PO_4 and urea phosphate existing together in the aqueous phase. The succe'ssful method suitable to determine the percentage conversion in the reaction mixture should be fast enough to avoid errors resulting from further interaction between urea and H_3PO_4 during the determination. It was then decided to determine the extent of conversion instantaneously by a pH value calibration technique. Artificial aqueous solutions were prepared containing varying proportions of H_3PO_4 and urea phosphate to conform wih the range of concentrations in the reaction mixture. The pH value of each of these artificially prepared solutions was measured and tabulated against the corresponding percentage conversion. A calibration chart was then made for each set of artificially prepared solutions conforming to a certain reaction mixture. On preparing the reaction mixture in the stirred beaker of the pH meter the readings were recorded at small intervals of time. From the relevant calibration chart the corresponding percentage conversions were obtained. Figure (1) illustrates the relation between the pH values of the solution and the corresponding weight percent conversion of H_3PO_4. It is observed that for the 15 wt% H_3PO_4 solutions, the recorded pH value of the solution differs with the temperature which is attributed to changes in the degree of dissociation of the acid with temperature. This is quite in good agreement with previous reported literature (2, 3, 4).

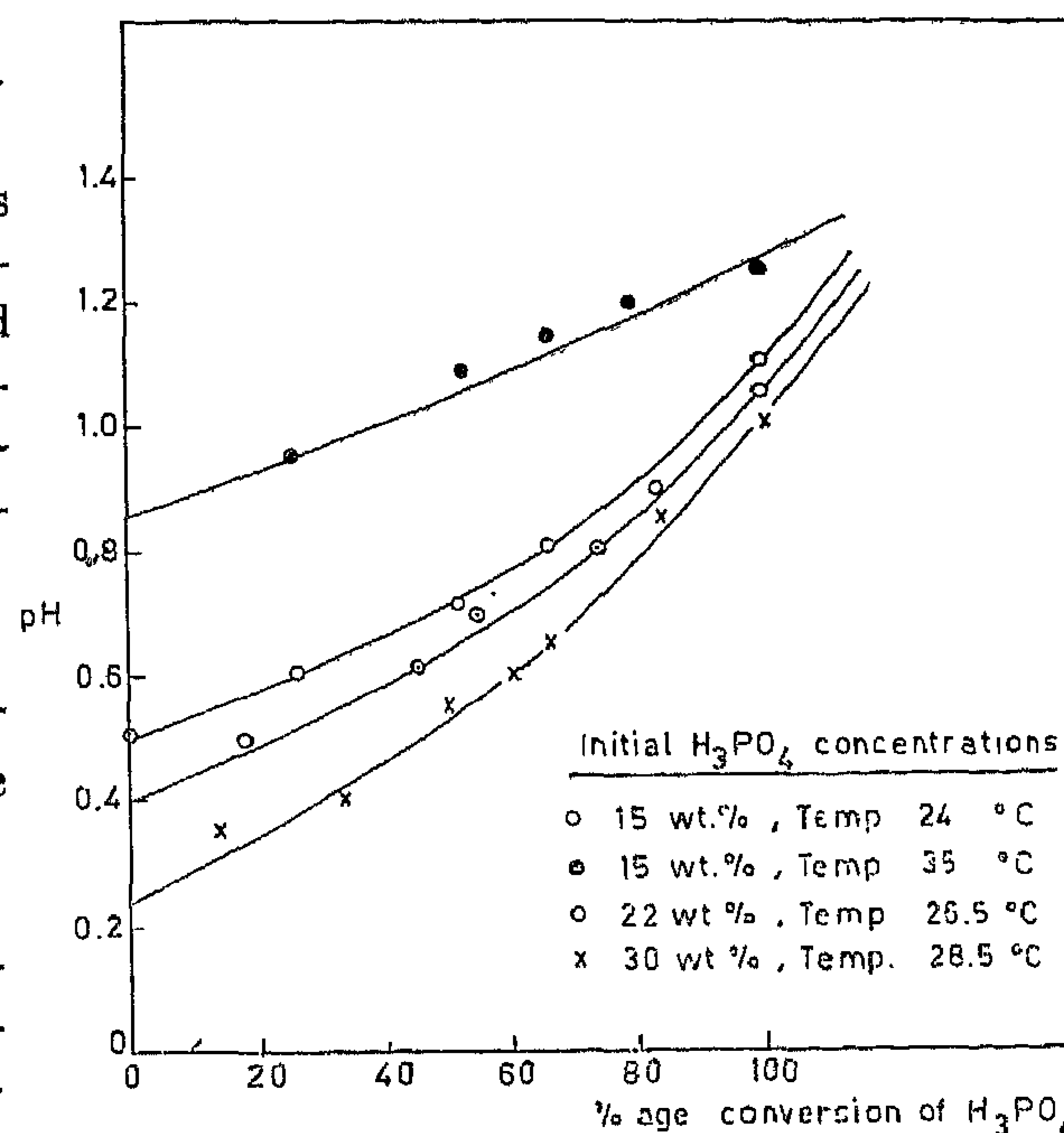


FIG. (1) Calibration Chart Using Artifitial Aqueous Solutions

(1.3) Experimental Conditions of Kinetics Study:

In each experimental run an aqueous solution containing the reacting components with a certain initial H_3PO_4 concentration was directly prepared in the mixing beaker of the pH meter. This was done by adding instantaneously two aqueous solutions, one containing H_3PO and the other containing the stoichiometric amount of urea with continuous stirring at a fixed rate. Different constant reaction temperatures of 24, 26.5, 28.5, and 35°C were maintained and the pH

UREA PHOSPHATE FORMATION KINETICS

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ABSTRACT

The reaction kinetics between urea and phosphoric acid in a homogeneous aqueous phase to form urea phosphate has been experimentally investigated. A pH value calibration technique was applied to determine the percentage reacted H_3PO_4. Varying initial H_3PO_4 concentrations of 15, 22, 30 wt% were used and reaction temperatures of 24, 26.5, 28.5, and 35°C were maintained to establish its effect on the reaction rate. The speed of rotation of the stirrer in the reaction mixture was adjusted at 100, 200, 300 r.p.m. as well as at much higher speeds. It has been found that the reaction is second order and the reaction rate constant was correlated in terms of Arhenious equation. The activation energy was estimated as 50,820 cal./gm. mole. The derived reaction rate equation was the same for stirrer operating speeds of 100, 200, 300 r.p.m. At much higher speeds the reaction was complete instantaneously indicating much higher reaction rates.

INTRODUCTION

Urea phosphate is one of the most important complex fertilizers developped recently. It contains both nitrogen and phosphorus which favours its use by consumers in case of plants requiring both components.

Data relevant to the kinetics of formation of urea phosphate is not reported in literature. Brief reports (1) indicate that it is formed as an addition compound where urea is mixed with phosphoric acid. As the manufacture of urea is considered an important petrochemical industry, the combination of urea with phosphoric acid to form urea phosphate fertilizer requires greater increase in urea production rates with extensive use of petroleum gases.

The investigations presented in this work are mainly intended to elucidate the reaction kineties between urea and phosphoric acid in an aqueous solution to form urea phosphate.

1. Experimental Work

(1.1) Specifications of Reactants and Measuring Instruments.

(a) Urea of analar grade, "VEB LABORCHEMIE APOLDA", pure white crystals.

(b) Phosphoric acid of analar grade, "E. Merck AG. Darmstadt".

Stoichiometric requirements of the reactants were determined from the equation:

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years and unrecovered capital is equal to cumulative investment at any particular year end minus cumulative net cash received at the same year end.

Risk units of a project may be related to total risk units of the company, which are defined as the product of total capital the company is investing and can invest multiplied by an acceptable average MPOT. For example, total risk units for a company of $ 200 million investment capacity with an MPOT of five years are $ 1,000 million years.

The proposed risk coefficient for any project under study is related to project and company risk units us follows :

$$RC = I - \frac{\text{Project risk units}}{\text{Company risk units}}$$

RC is always less than one. Values close to unity reflect that either project has shorter MPOT than average accepted period or that investment represents a small percentage of company investable capital, or both. Therefore, the project is less risky, conversely, smaller risk coefficients indicate larger risk element in terms of a longer payback period of higher project cost, in relation to company investment capacity.

The introduced risk evaluation approach is believed superior to the use of payback period or other presently known methods. It considers both risk period and volume of unrecovered capital. The risk coefficient depends on total risk units for the company. Management may set a suitable fixed number based on its success and volume of activities, but there will always be one company value to use for comparison of alternatives. Therefore, relative risk coeefficient should always be sound.

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TABLE 4 Calculation risk units and risk coefficient

Yrs	(1) Cumulative invest. at year end	(2) Cumulative net cash at year end	(3) Unrecovered capital at year end	(4) Risk period, Yrs.	(5) = (3) X (4) Risk units, Col.3 X Vol. (4)
1	2,24 0	......	2,240	4.75	10,640
2	9,565	......	9,565	3.75	35,869
3	16,313	......	16,313	2.75	44,861
4	18,271	7,290	10,981	1.75	19,217
5	20,464	15,455	5,009	0.75	3,757
5.75	22,920	22,920	0	0	0
	Total risks units				114,344

MROT for this project is 5.75 years.

Table shows that project risk units are about $ 114 million years. Assuming that the company's total risk unis are $ 1,000 million years, risk coefficient would be

$$\left(1 - \frac{114}{1,000} \right) = 0.89.$$

Modified payout time (Table 3) is a better measure for reflecting riss. It has the important feature of showing how long company money will be at stake.

It is reasonable to expect that the longer it takes to recover an investment, the greater is the risk of recovery. Thus, payout time is a valid measure of a major risk element. MROT takes the time value of money ant time shape distribution of earnings into consideration.

The method of determination is outlined as follows :

- Cumulative future value of investment and net income are determined for each year. Compounding is done at the interest rate at which corporate funds are invested.

- A plot of future values versus time is made for the investment and the net income, and intersection of the two curves gives true or modified payout time, see figure.

Risk units and coefficient (Table 4). The risk element is related both to payback period and to volume of unrecovered capital, i.e., a $ 10 million value at stake for one year represents more risk than a $ 5 million value unrecovered for the same time period. Also, the economic climate and company strategy concerning availability of investable capital in various operations plays an important role in risk consideration. An organization with $200 million invested in different projects can certainly stand more risk than a company with total invested capital of only $50 million.

This discussion introduces the risk units concept with the money-time dimension. Proposed total risk units of a proposal can be obtained through the equation :

$$\text{Risk units} = \sum_{n=I}^{n=MPOT} (\text{unrecovered capital}) (\text{MPOT-n}),$$

where : n is number of years since the investment was commenced, MPOT is in

investments may be different than estimated and the cash flow pattern may deviate in yearly values or life.

Most industry projects require long range planning, and probability of deviations is almost certain. Good engineering judgement may tolerate a 10% deviation. It is suggested that the proposed sensitivity coefficient utilizes this factor. Any company may use a different percentage based on experience but the basic approach would be the same.

The method of calculating sensitivity or stability coefficient is outlined as follows.

- An optimistic MROR is calculated using a hypothetical stream of investments reduced by 10%, and a hypothetical flow for future values of net income increased by 10%.
- A pessimistic MROR is calculated in a similar fashion. MRORs thus calculated would be the highest and lowest expected returns under good engineering judgement and excluding the risk element.
- The sensitivity coefficient then is calculated using the following formula :

$$SC = I - \left(\frac{\text{Optim MROR} - \text{Pessim MROR}}{2 \times \text{Expected MROR}} \right)$$

SC will always be less than one. The closer the coefficient is to unity, the more stable the project is, i.e., small variations in forecasted investment due to price changes or errors in cost evaluation will have insignificant effect on the calculatedMROR And, reasonably accepted errors in forecasting yearly net cash flow or in estimating economic life will not appreciably change MROR.

Conversely, smaller SC values indicate that minor changes in actual investment and net cash flow patterns would result in appreciable MROR changes. This, of course, reduces project attractiveness.

TABLE 3 — Modified payout time

Yrs.	Net Cash Flow, $ 1,000			Investments, $ 1,000		
	During year	Total at irst o fyea	Total at nd of year	During year	Total ,rst of y	Total end of y
1	......	......	......	2,000	2,000	2,240
2	......	......	......	6,300	8,540	9,565
3	......	......	......	5,000	14,565	16,313
4	7,290	......	7,290	......	16,313	18,271
5	7,290	7,290	15,455*	......	18,271	20,464
6	7,290	15,455	24,600	......	20,464	22,,920
7	7,290	24,600	34,842	......	22,920	25,670
8	7,290	34,842	46,313	7,700	33,370	37,374
9	8,060	46,313	59,931	......	37,374	41,859
10	8,060	59,931	75,183	......	41,859	46,882
11	8,060	75,183	92,265	......	46,882	52,508
12	8,060	92,265	111,397	......	52,508	58,809
13	8,560	111,397	133,325	......	58,809	65,866

* Future values are determined by compounding at 12%. For example : Total net cash at end of 5th year. = 7,290 + (7,290 × 1,12) = 15,454.

Year end values of net cash and investment vs. time are plotted in accompanying figure.

TABLE 2 Sensitivity or stability coefficient

Pessimistic rate return	Optimistic rate of return
Discount factor = $\frac{15{,}091 \times 110}{133{,}291 \times 90}$ = 0.1384	Discount factor = $\frac{15{,}091 \times 90}{133{,}294 \times 110}$ = 0.0926
This corresponds to a rate of return of 16.4%	This corresponds to a rate of return of 20.1%. And, sensitivity coefficient = $1 - \left(\frac{20.1 - 16.4}{2 \times 18.3}\right) = 0.90$

Modified rate of return (Table 1) is defined as that interest rate which results in the discounted present worth of total future value of net income plus salvage equal to the discounted present worth of investment, in such a way as to allow reinvestment of the generated funds at the average value of money to the company.

The method for calculating MROR is outlined as follows :

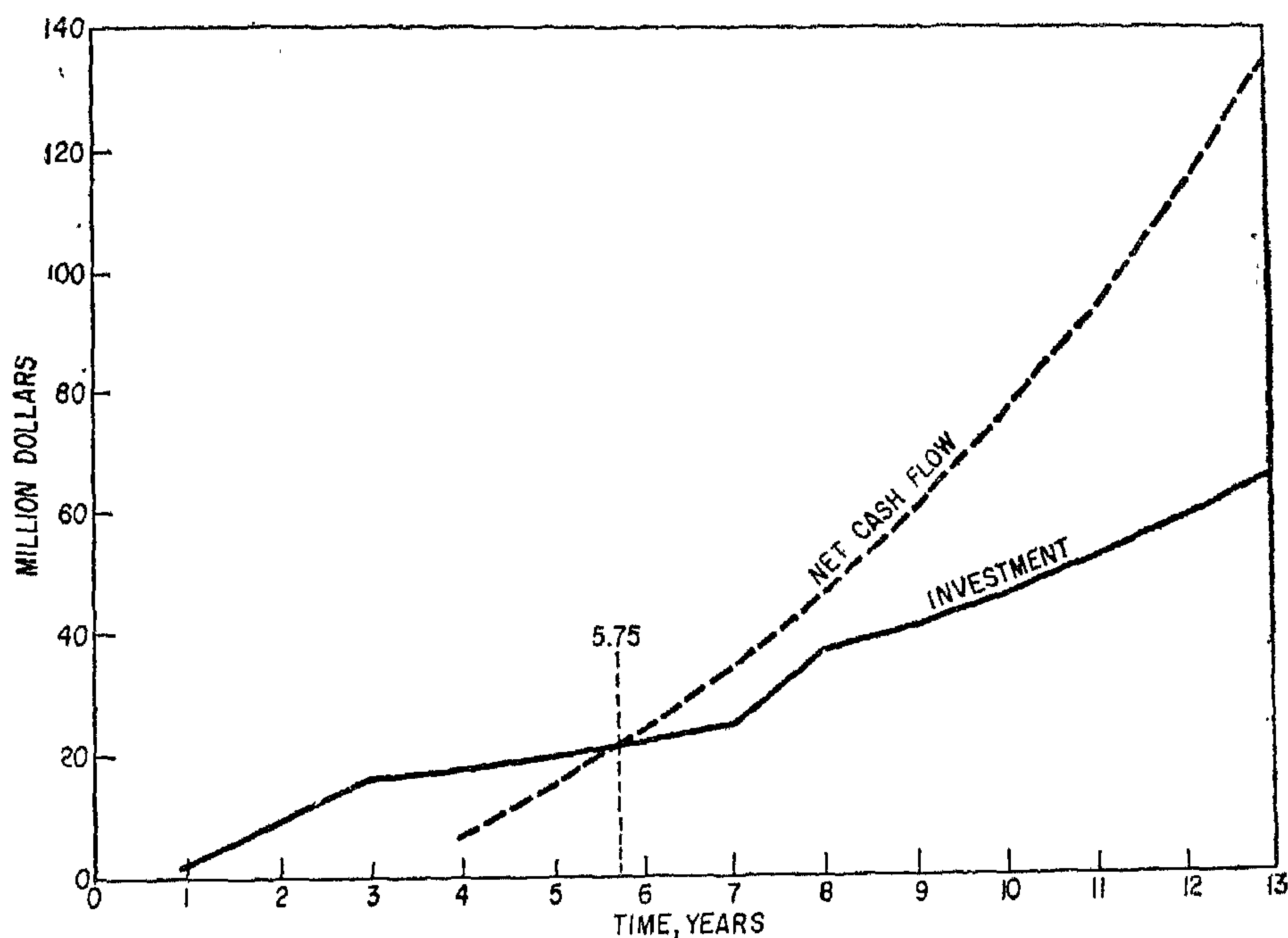
- The present value of various investment elements is determined at the average rate at which general corporate funds are being invested
- Total present value of various investment elements is calculated
- The future value of various net cash income elements is determined, assuming that direct net cash income from investment will be reinvested in company activities at the average rate of return being made on general funds. The first year's income is compounded at that interest rate for (n-1) years, the second year's income from (n-2) years, and so forth, where (n) is economic life of the project.
- The total future value of various elements of net income is calculated. This value is total amount which will have been generated by end of the project's economic life .
- The compound interest which results in discounted present worth of investment (second step) being equal to total future value by end of economic life of project (fourth step) is the modified rate of return. This can be readily determined from interest tables.

MROR represents project attractiveness compared to investing in general company business. The figures obtained are more realistic than those obtained from discounted cash flow calculations. Absolute accuracy depends largely on accuracy of estimating average rate of return the company makes on its general funds. However, this value can be obtained statistically from past performance.

With this method there is only one value for each company to use in comparing all alternatives. Therefore, the relative ranking is always sound. And, MROR is obtained from a straight forward calculation eliminating the trial and error approach. Simplicity adds to its attractiveness

Stability coefficient (Table 2).

Evaluations are based on engineering estimates of future action. Neither engineering nor economics is a pure science with solid mathematical relationships. Therefore, any calculated rate of return cannot have a completely tangible base. Actual



Graphical illustration of modified payout time calculations of Table 3 clearly shows time, 5.75 years, when total net cash flow at year end equals total investment.

TABLE 1 — Modified rate of return

Yrs.	Net cash flow, $ 1,000				Investments, $ 1,000			
	Net cash	Compound period, yrs.	Compound factor a 12%	Future value, Col. 1 x Col. 3	Investment	Discount period, yrs,	Discount factor a 12%	Present value, Col. 5 Col. 7
1	......	12	......	......	2,000	0	1.000	2,000
2	......	11	......	......	6,300	1	0.893	5,626
3	......	10	......	......	5,000	2	0.797	3,985
4	7,290	9	2.772	20.208	......	3	......	......
5	7,290	8	2.475	18.043	......	4	......	......
6	7,290	7	2.210	16.111	......	5	......	......
7	7,290	6	1.973	14.383	7.700	6	......	......
8	7,290	5	1.762	12,845	......	7	0.452	3,480
9	8,060	4	1.574	12.686	......	8	......	......
10	8,060	3	1.405	11.324	......	9	......	......
11	8,060	2	1.254	10.107	......	10	......	......
12	8,060	1	1.120	9.027	......	11	......	......
13	8,560	0	1.000	8.560	......	12	......	......
Total future value of net cash flow				133,294	Total present value of investment			15,091

Discount factor at end of 13th year =

$$\frac{15.091}{133,294} = 0.1132$$

From interest tables, by interpolation, discount factor of 0.1132 at end of 13th year corresponds to 18.3% interest rate. Therefore, expecter MROR is 18.3%.

SIMPLIFIED PROFIT INDEX AIDS ECONOMIC EVALUATIONS

H. A. EL BANBI* and A. S. EL MEKKAWY**

10-second summary

Proposed simplified economic evaluation method illustrated by an example calculation tells how to combine three main evaluation elements into a single index indicating relative merits of several proposals.

INDUSTRY MANAGEMENT continually faces the problem of selecting the best investment from several alternatives involving large sums of money. A method for assigning an index of economic merit to each proposal, for comparing relative potential, would be valuable.

The proposed profitability index (PI) outlined in this article offers such capability. A multiple yardstick that analyses several criteria, the PI accounts for reinvestment of generated income at an average corporate fund rate, stability of the calculated rate with changes in inome and investment flow streams, and the risk element.

Proposed evaluation method. The most serious evaluation problems are first encounteret in adequately measuring a true rate of return and its stability considering variations in cash and investment streams, and, secondly, in providing a suitable means for incorporating risk.

The profitability index method consists of three calculations for :

1. A modified rate of return (MROR) that realistically represents true project profitability from an engineering evaluation standpoint.

2. A stability or sensitivity coefficient (SC) that accounts for variations in net cash and investment streams beyond control or expectations of the evaluator, and

3. A risk coefficient (RC) related to a true payout time to account for unforseen drastic changes of utility or obsolescence.

All of these coefficients may be viewed separately or jointly to assist in making decisions from alternatives. The proposed profitability index is their product, defined by the equation :

$$PI = MROR \times SC \times RC$$

Tables 1 through 4 and one curve illustrate the calculation procedure for various PI elements. Data from an actual case with rather complicated net cash flow and investment pattern are used to show how this new method is applied. It is assumed that the reinvestment opportunity is at 12% per annum. Results obtained show that the MROR is 18.3%, SC is 0.90, RC is 0.89, And, therefore, the PI is 14.7.

* Chief Petroleum Engineer

** Operations Manager, Western Desert Operating Petroleum Co. (WEPCO), Alexandria, Egypt

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— Articles may not exceed 8 pages. In this respect, mathematical derivations may be abbreviated and tables replaced by curves.

— Curves to be drawn in black china ink, and to occupy half a page at most. Exceptionally, full page curves or plates are admitted. Curves presented will be scaled down to these sizes. Figures & lettering on curves should not be less than 3 mm even after scaling down.

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- تذكر أسماء أصحاب المقـالة كاملة باللغتين ومعها ألقابهم العلمية ووظائفهم .
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- يعنى بذكر المراجع المستقى منهـا المقـال وتصنف تبعا لاسم المؤلف ثم العنوان ثم المجـلة أو الكتاب وتاريخه .
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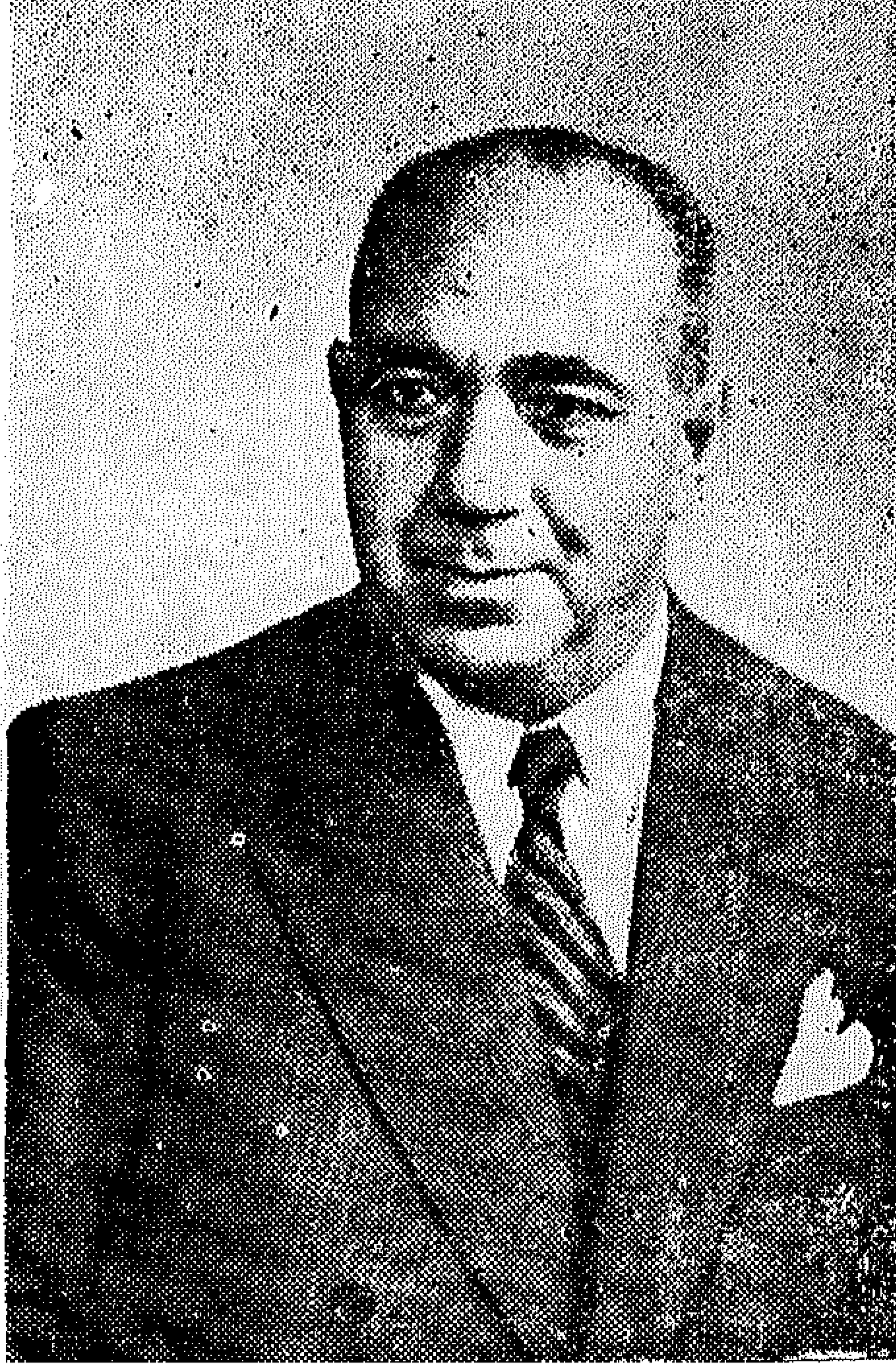
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جمعية المهنـــدسين المدنيين
جمعية المهندسين المعماريين
جمعية مهندسى الرى



فى ذمة الله

من الناس من يبلغك أمره ، فتود أن تراه . واذا ما لقيتـه ، أعجبك قوله ، واستأنست لحديثه ، فتطلب مودته ، وتروم صـداقته . فاذا به صادق الوعد ، وفى العهد ، يهـديك بمعرفتـه ، ويرشـدك بتجربتـه ، فتستمسك به . وكلما نمت أواصر المحبـة بينكما ، زاد تقـديرك له ، واعتزازك به ، لسعة أفقه ، وسديد رأيه ، وبالغ حكمته .

ومن هـذه القلة النـادرة ، والنخبـةالممتازة ، زميلنـا الراحل الكريم محمـد عبد الغنى الخولى ، غفر له ، آمين .

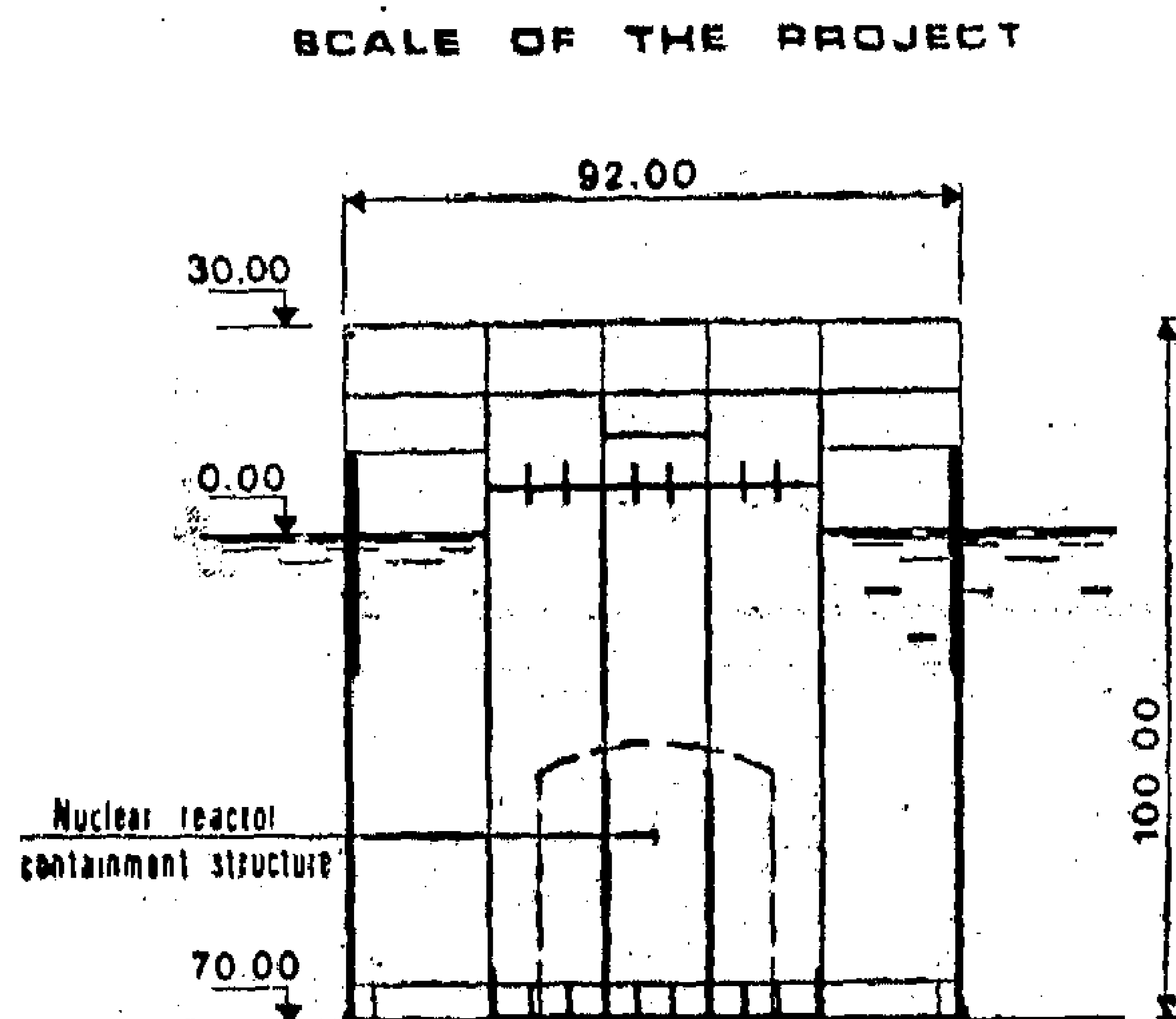
نشأ ، رحمـه الله ، فى عائلة كريمة ،ببلدة سبرباى ، القريبة من طنطا ، بصرة الدلتـا . ثم طلب العلم فى فينـا وبرلين ،والتحق بهيئة التدريس بالجيزة . وما زال يرقى سـلمها ، حتى صـار رئيسا لقسمالكهرباء ، فوكيلا لكلية الهندسة ، بجامعة القاهرة . ثم غادرنا ، ليتقلد عمادة شقيقتها ، بجامعة عين شمس .

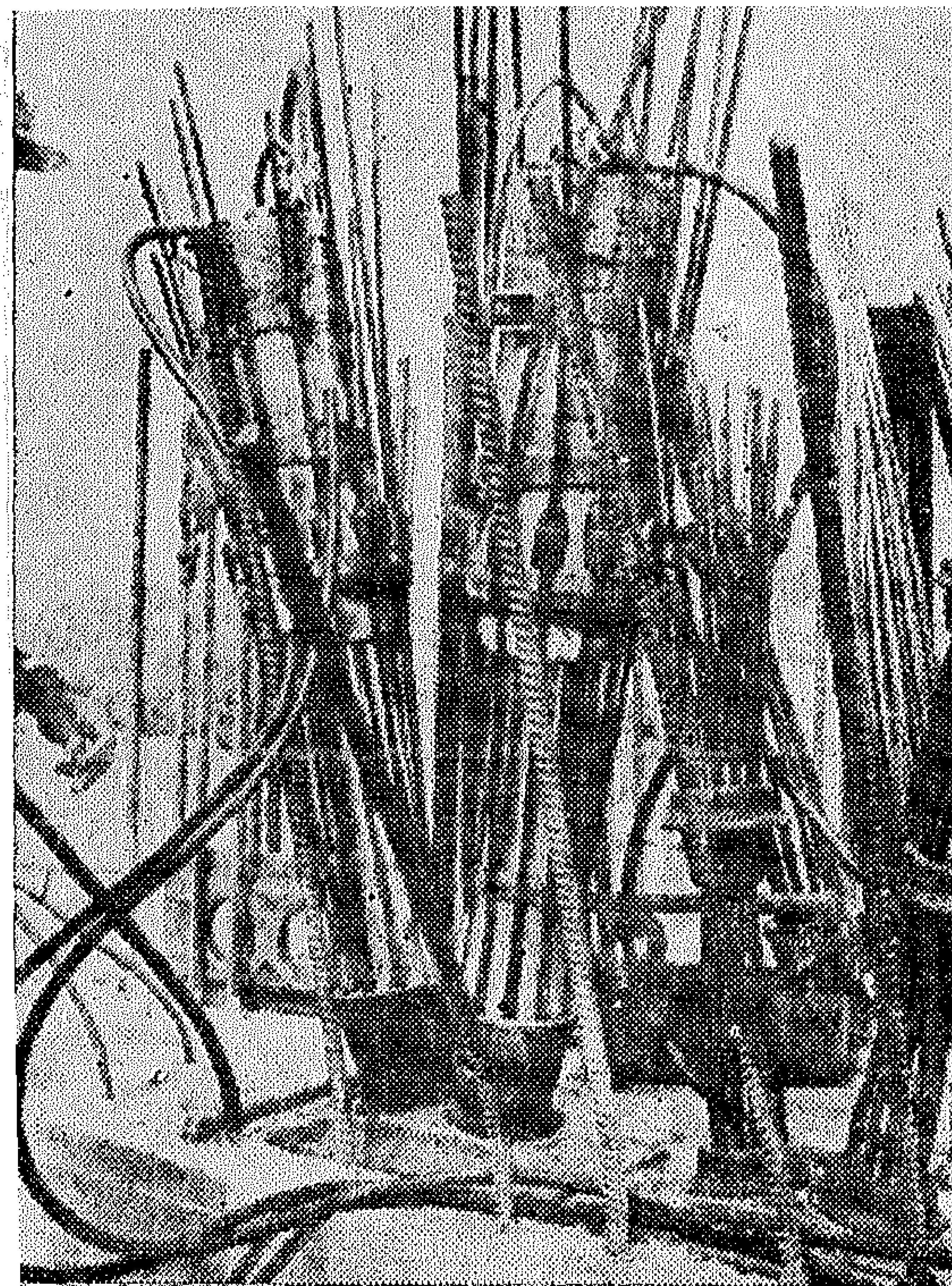
وبذلك يكون قد أسهم فى تدعيم قسمالكهرباء عندنا ، وترسية القواعد الجامعية عندهم . كما ألقى بدلوه فى ميدان البحوث،ومثل مصر فى المؤتمرات الدولية . ولم يبخل بما يعرف على من استشاره من الوزاراتالهندسية .

وأشهد الله ، أنى ما رأيت منه الا برا ،وما سمعت عنه الا خيرا .

ولعـل أبرز ما تحلى به ، رحمـه الله ،الصمت والصبر ، شأن أولى العزم . فقد صارعه المرض فى شـبابه ، ولم يصرعه .فعاوده بعدها ، ولم يقهره . حتى اذا ما بلغ أجله ، أتاه اليقين ، وقد جاوز السبعين . فسلام عليه فى الأولين ، وسلام عليه فى الآخرين ، الى يوم الدين .

ابراهيم ادهم الدمرداش





FREYSSINET 24 STRANDS 1/2" TENDONS ▲

5. Construction

In the first stage of construction the raft with the bottom and top slabs, and the breakwater wall to a height of 9 m were constructed in a dry dock near Stavanger, Norway.

The raft and the slabs were formed conventionally but the breakwater wall was formed with thin precast elements of high strength plain concrete which had the shape of a tube with square flanges at both ends. The breakwater wall was essentially built of reinforced concrete with some prestressing applied circumferentially at the top 35 m of the perforated wall. A number of inclined tendons were also provided in lower portion.

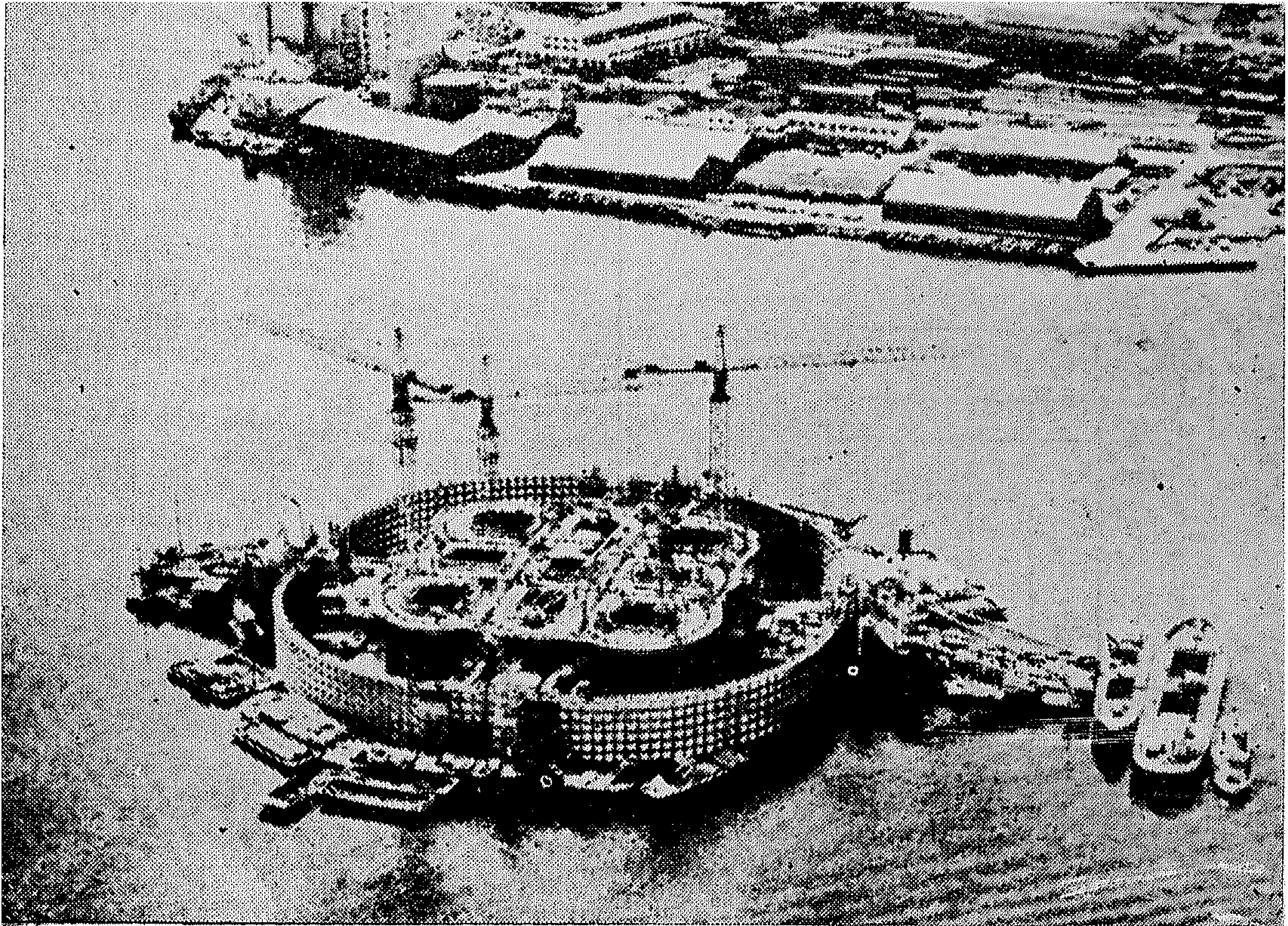
The rebars and the prestressing steel were placed in the spaces between the elements before they were filled with high strength concrete.

After completion of the first construction stage, the holes of the breakwater wall were temporavily closed to allow the 44000 ton raft to be floated and towed to the nearby fjord.

In the second stage of construction the vertical reservoir walls and the diaphragms were slipformed. As the wall height increased, the tank kept submerging so that only a small part of the total construction was above sea level The given figures show some of the above mentioned stages.

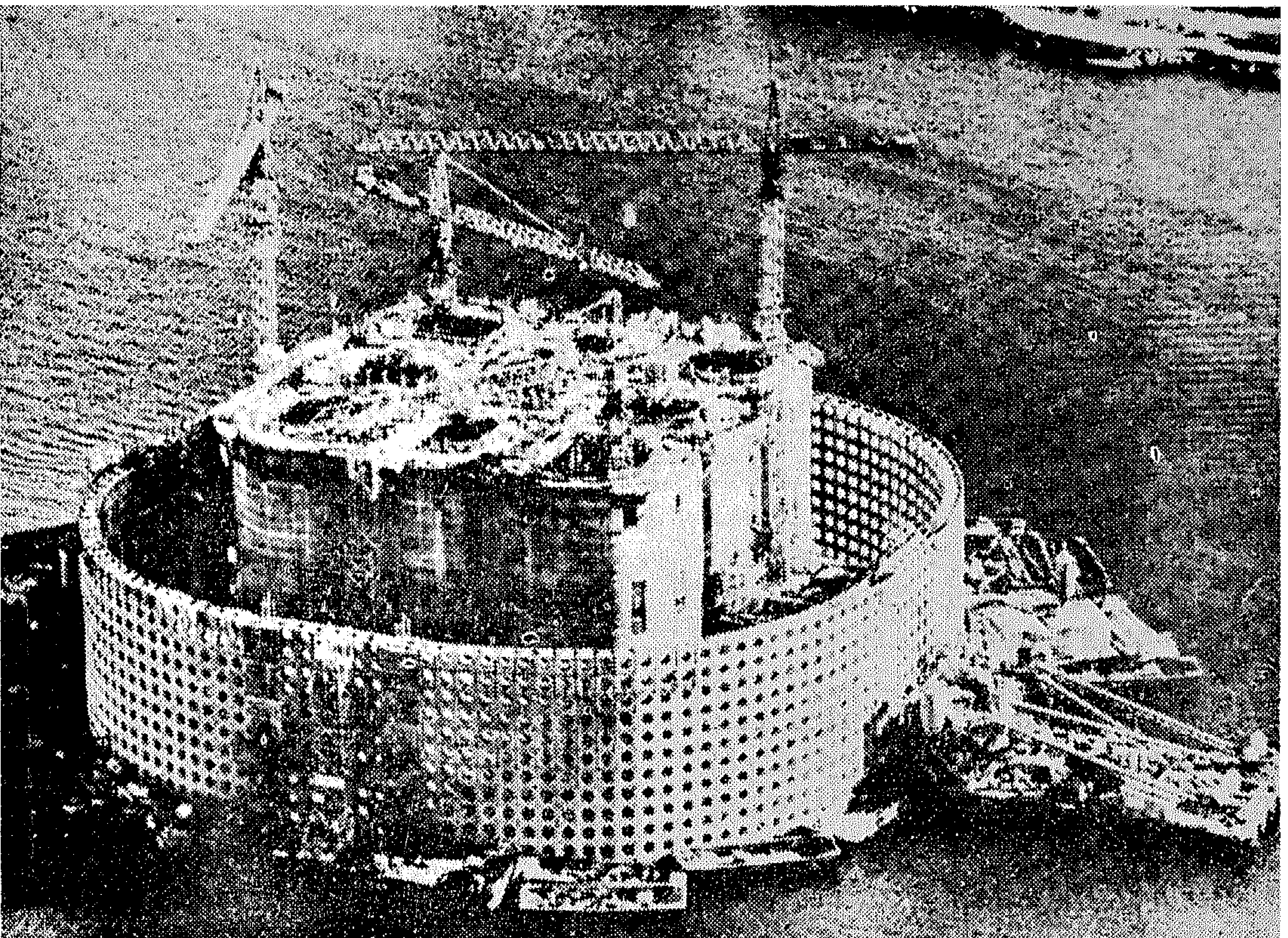
The Finite Element Analysis

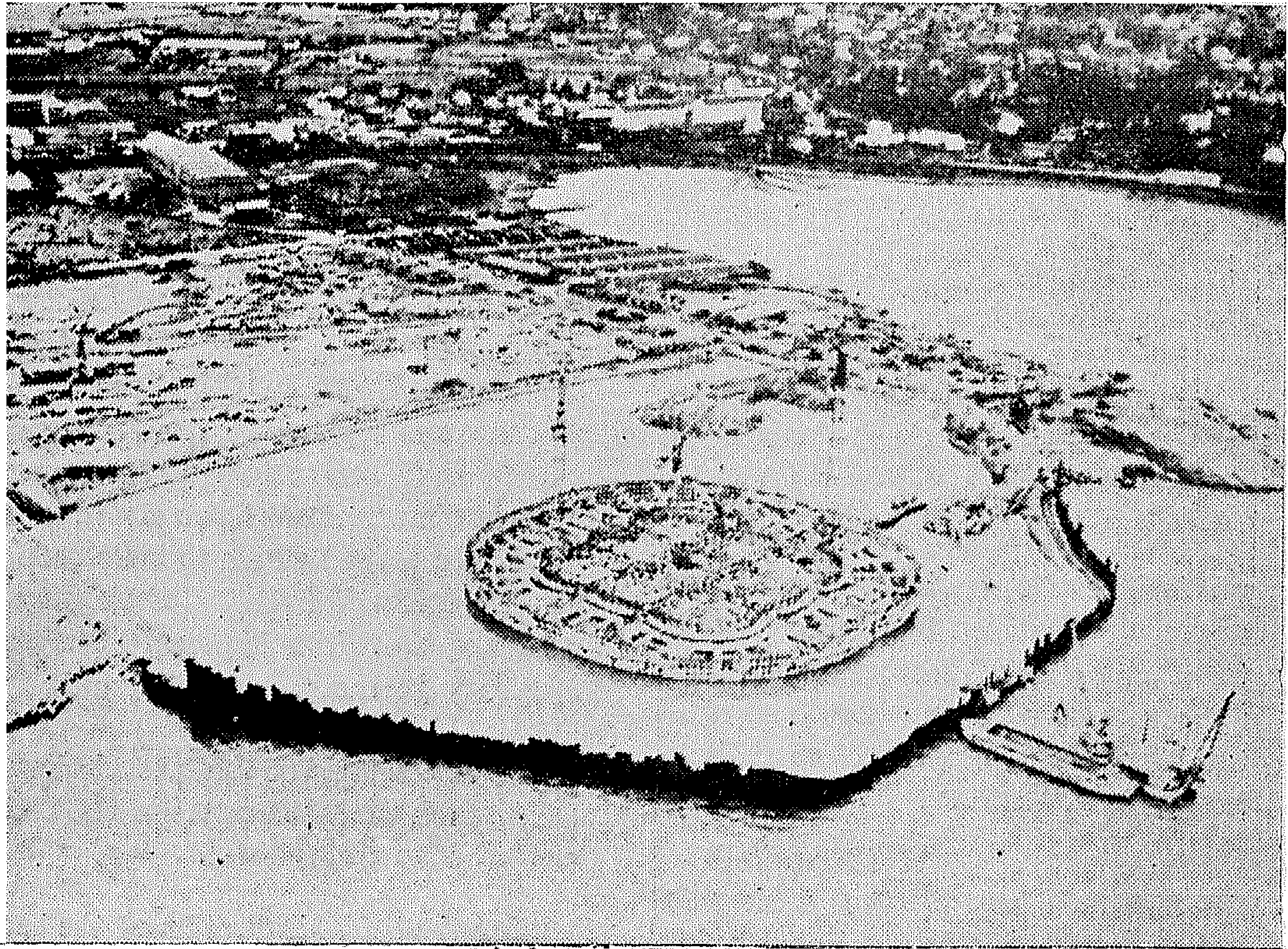
G. NASSAR



TYPICAL CONSTRUCTION PHASE ▲

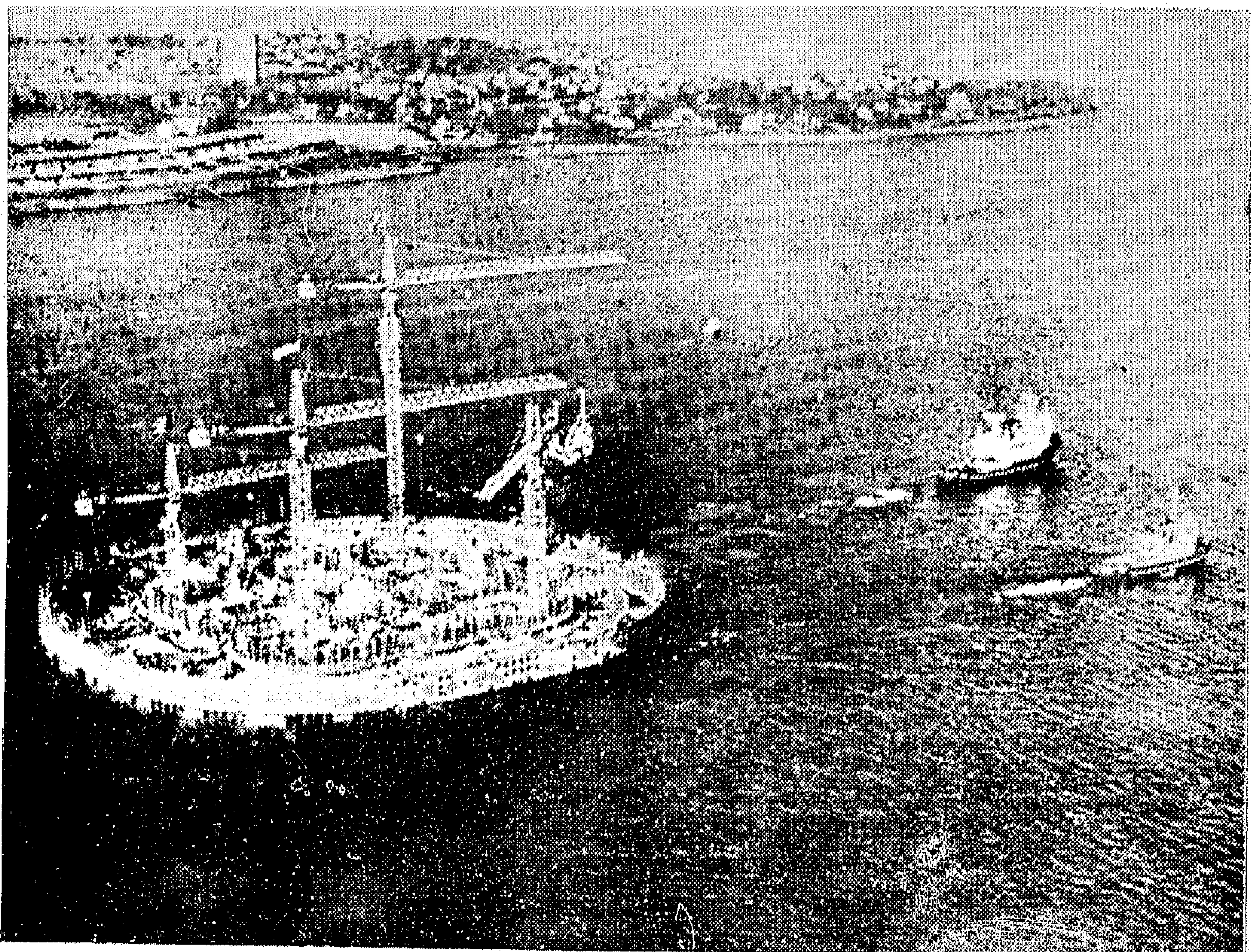
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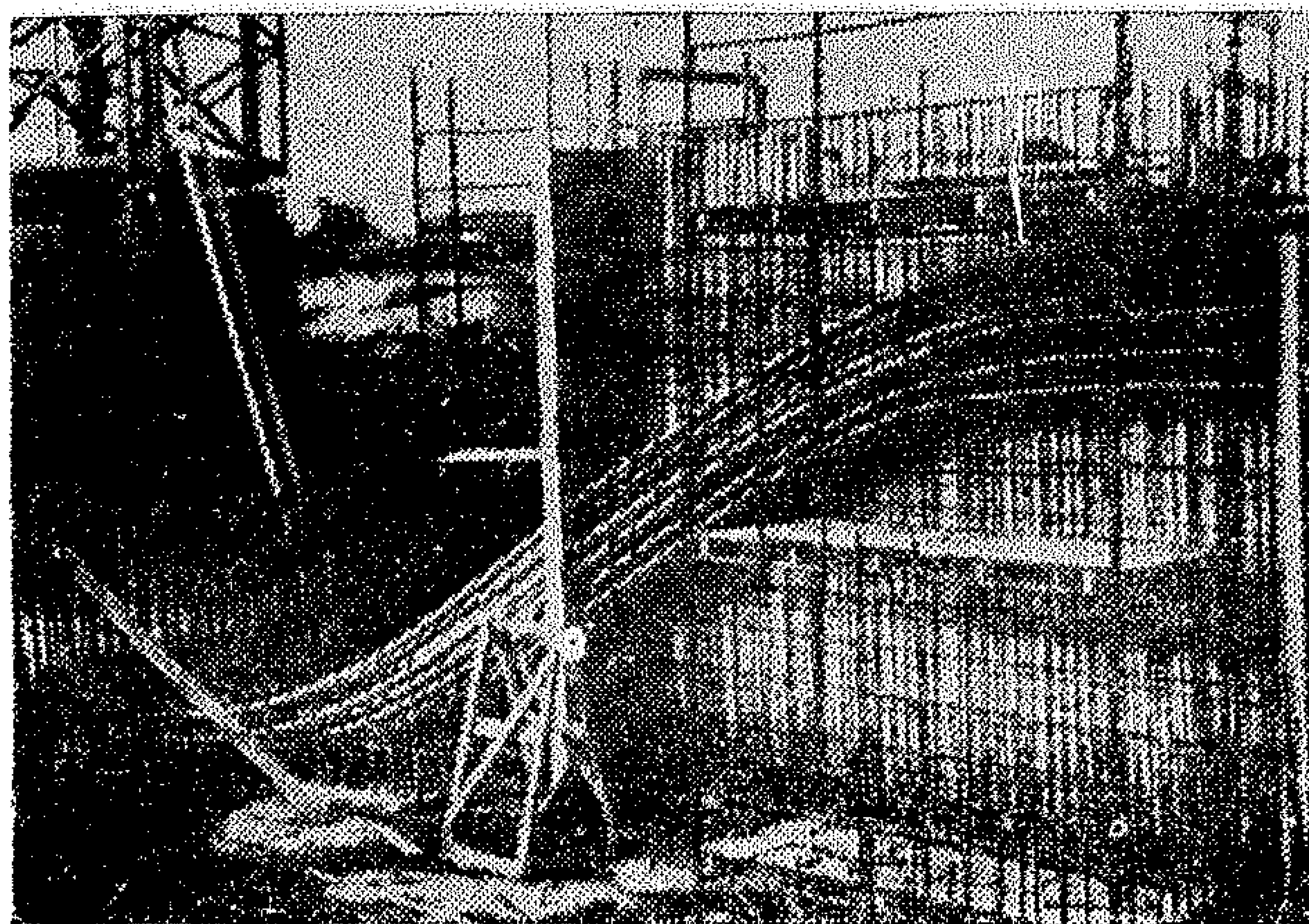




FLOTTATION IN DRY DOCK ▲

▼ TOWING



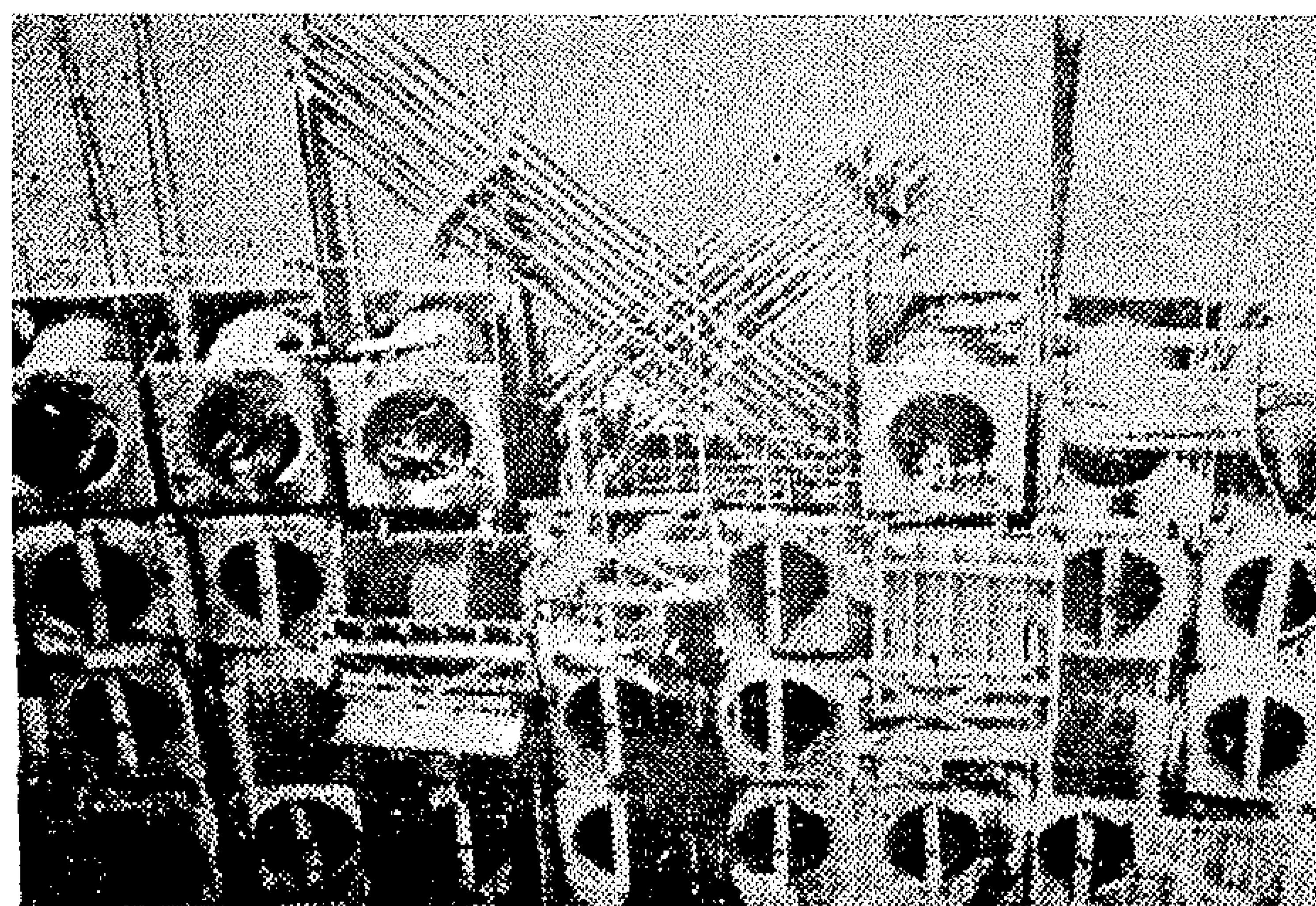


PRESTRESSING BEAMS OF RAFT FOUNDATION

vertical tensile loading). Under the action of the 24m 100 year wave there is uplift of the base slab over approximately 20 m along a diameter. The break - water wall must then assure load transfer.

THE FINITE ELEMENT ANALYSIS -

The dimensioning of the tank was based on preliminary conventional analysis of individual parts of the structure. In the three-dimensional F.E. analysis carried out by the authors of the present contribution, the whole tank was analyzed as one continuous structure. The loading cases investigated were: self-weight, water pressure during and after construction, oil pressure, wave action, prestressing and temperature effects resulting from the high oil temperatures. Because of symmetry of the structure, only one quarter of the structure was analyzed. The analyses for wave action were performed by superposition of symmetrical and asymmetrical loadings.



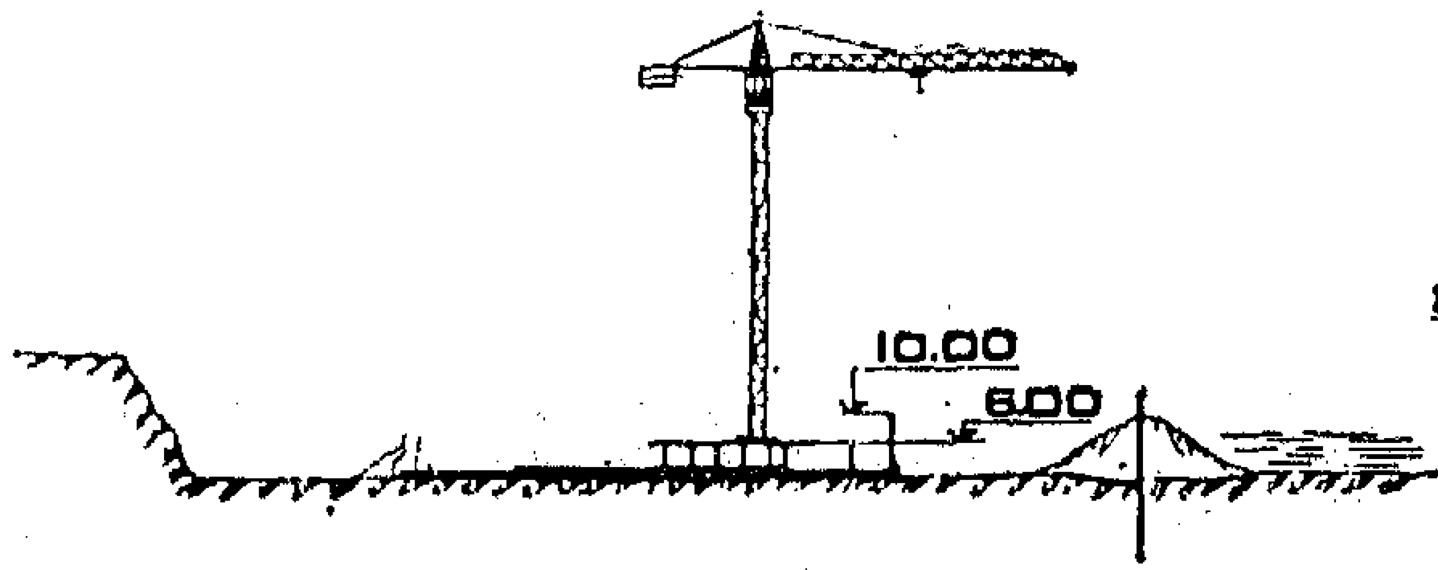
PLACING OF DIAGONAL TENDONS

The number of elements used for the analysis of the structure was about 1000, requiring solution of approximately 5000 simultaneous equations. In order to achieve maximum accuracy, the F.E. mesh was chosen finest in the zones of high stresses and high stress gradients, particularly near the bottom of the oil reservoir, and new refined finite elements were used. The refined elements have been developed at the University of Calgary for analysis of modern highway bridges of arbitrary geometry.

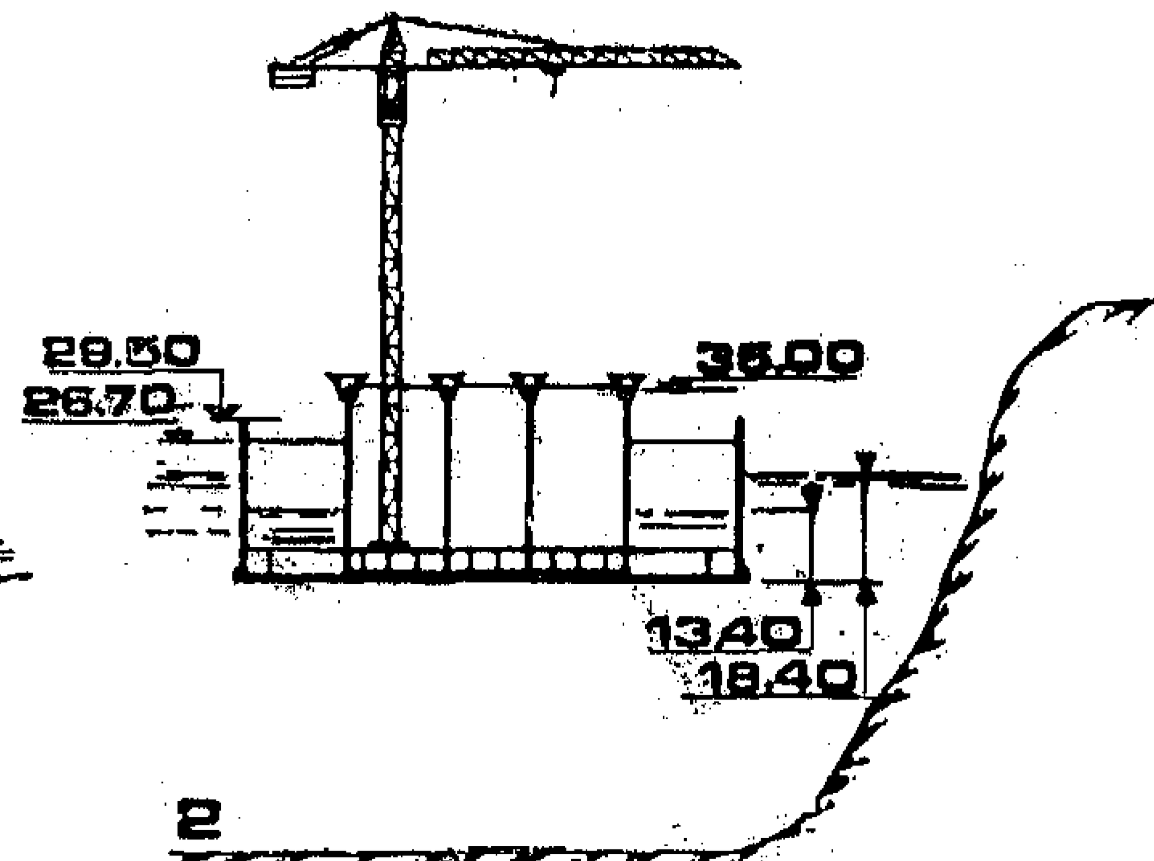
As an example of the F.E. idealization of the tank the mesh used for the bottom slab of the raft is shown.

For the F.E. idealization of the breakwater wall, advantage was taken of the fact that the size and the pattern of the holes was regular. In a separate F.E. analysis a "reduced" stiffness of the perforated shell was derived which was used for the final analysis. This reduced stiffness was found by relating elasticity matrices for the in-plane and bending conditing of a solid square plate to those of a square plate wth a hole in its middle; in other words, the perforated wall was transformed into an equivalent solid wall. The boundaries of the finite elements could therefore be chosen irrespective of the actual position of the holes.

Even though a large computer was available and the number of elements had been restricted to about 1000, the huge system of equations (maximum half band width 1050) could only be solved after a Gaussian elimination techniques had been special solution subroutine using block-developed.

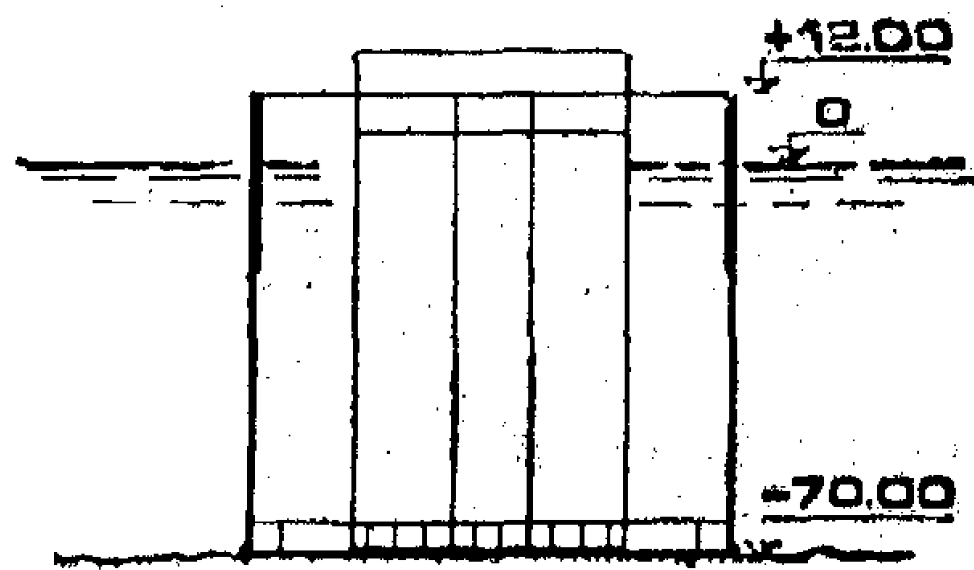


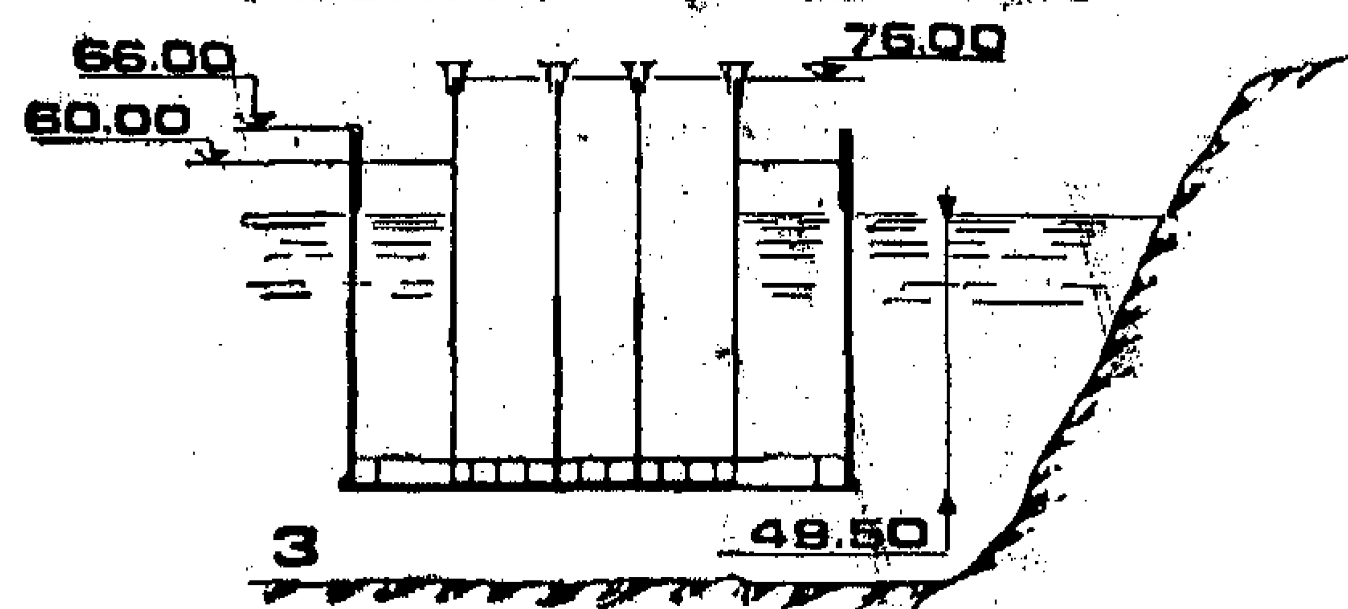
1. CONSTRUCTION EN CALE SECHE
CONSTRUCTION IN DRY DOCK

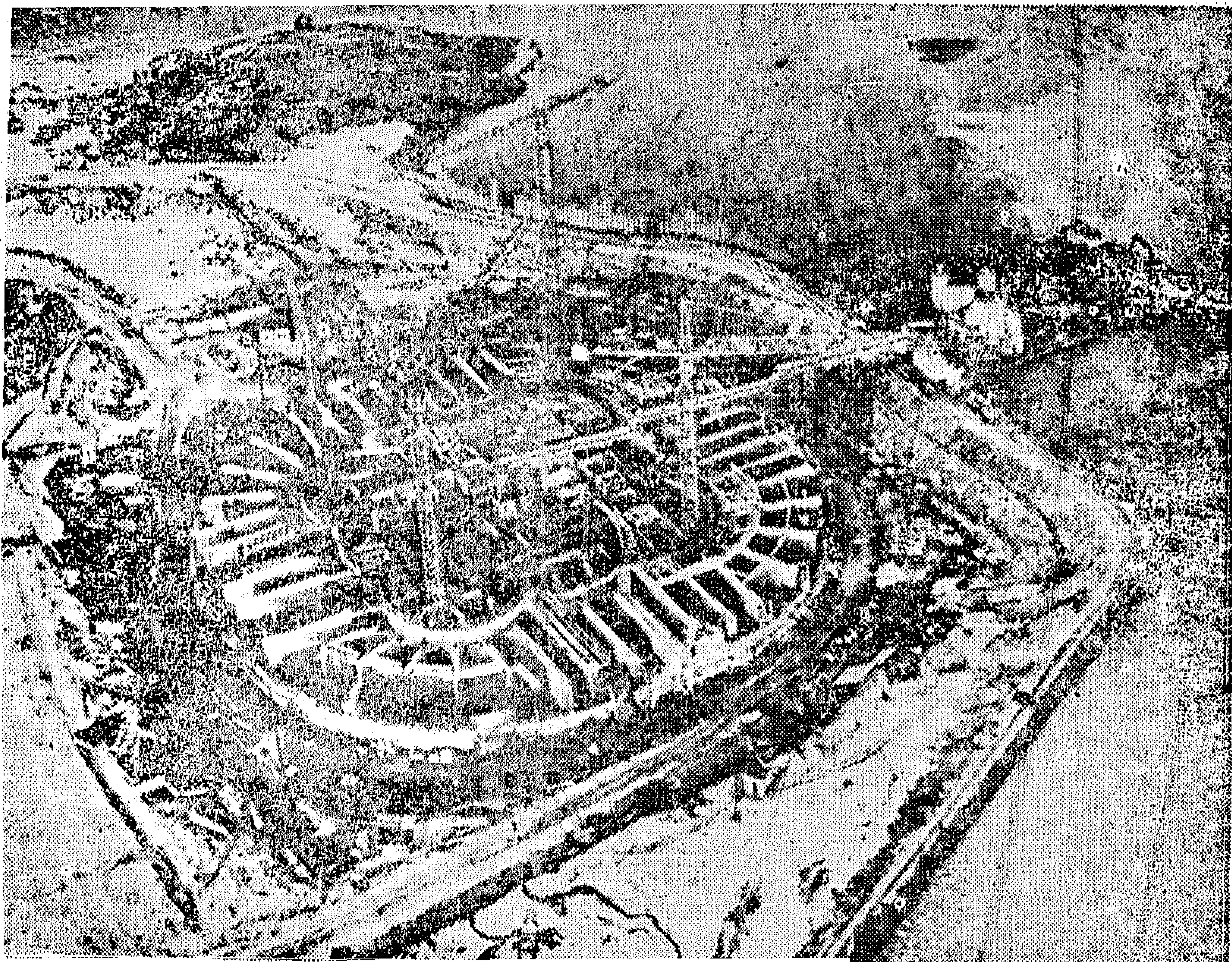


CONSTRUCTION EN FLOTTAISON
AVEC COFFRAGES GLISSANTS
SLIP FORM CONSTRUCTION IN
FLOATING CONDITION

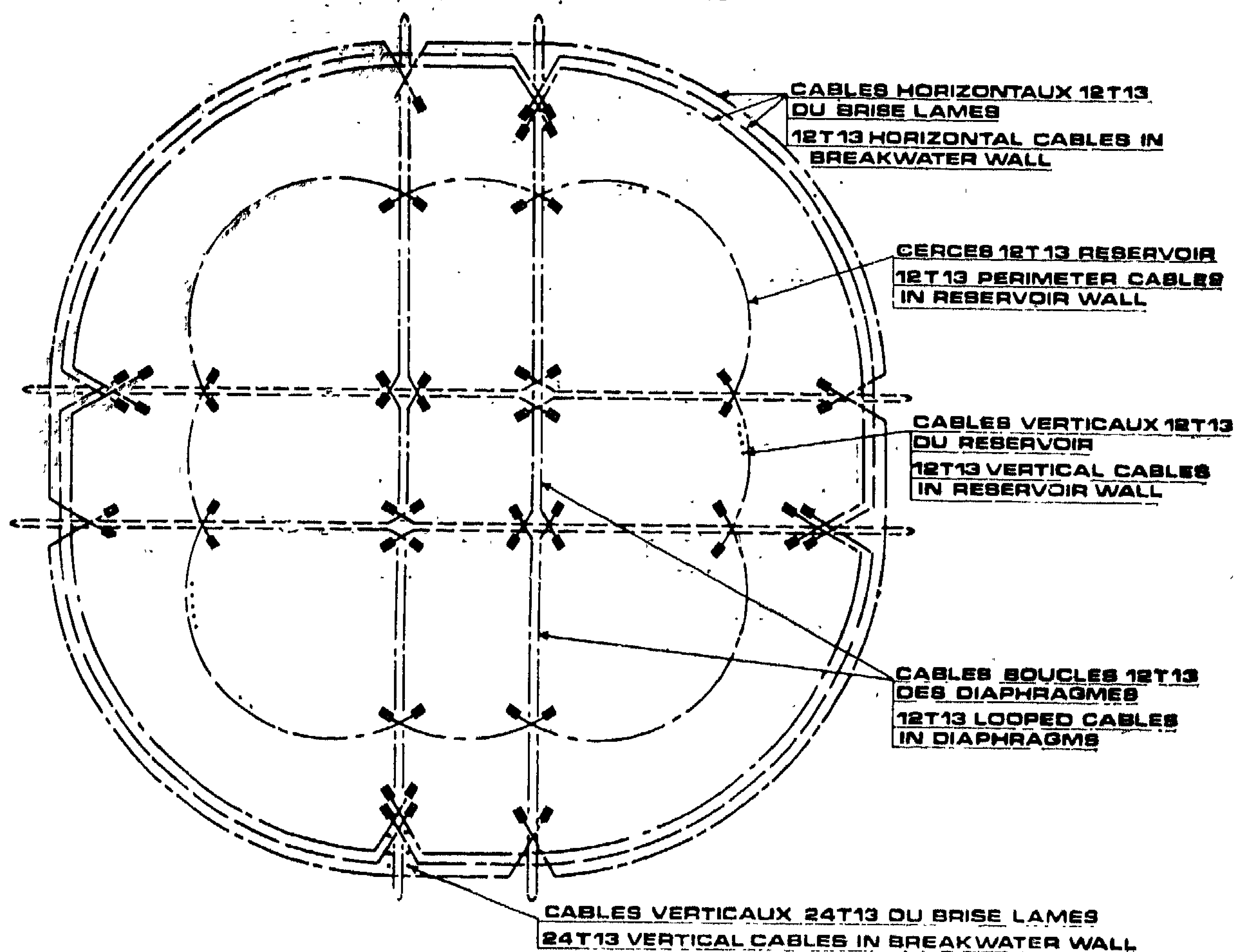
4. RESERVOIR ECHOUE
LANDED RESERVOIR







CONSTRUCTION IN DRY DOCK



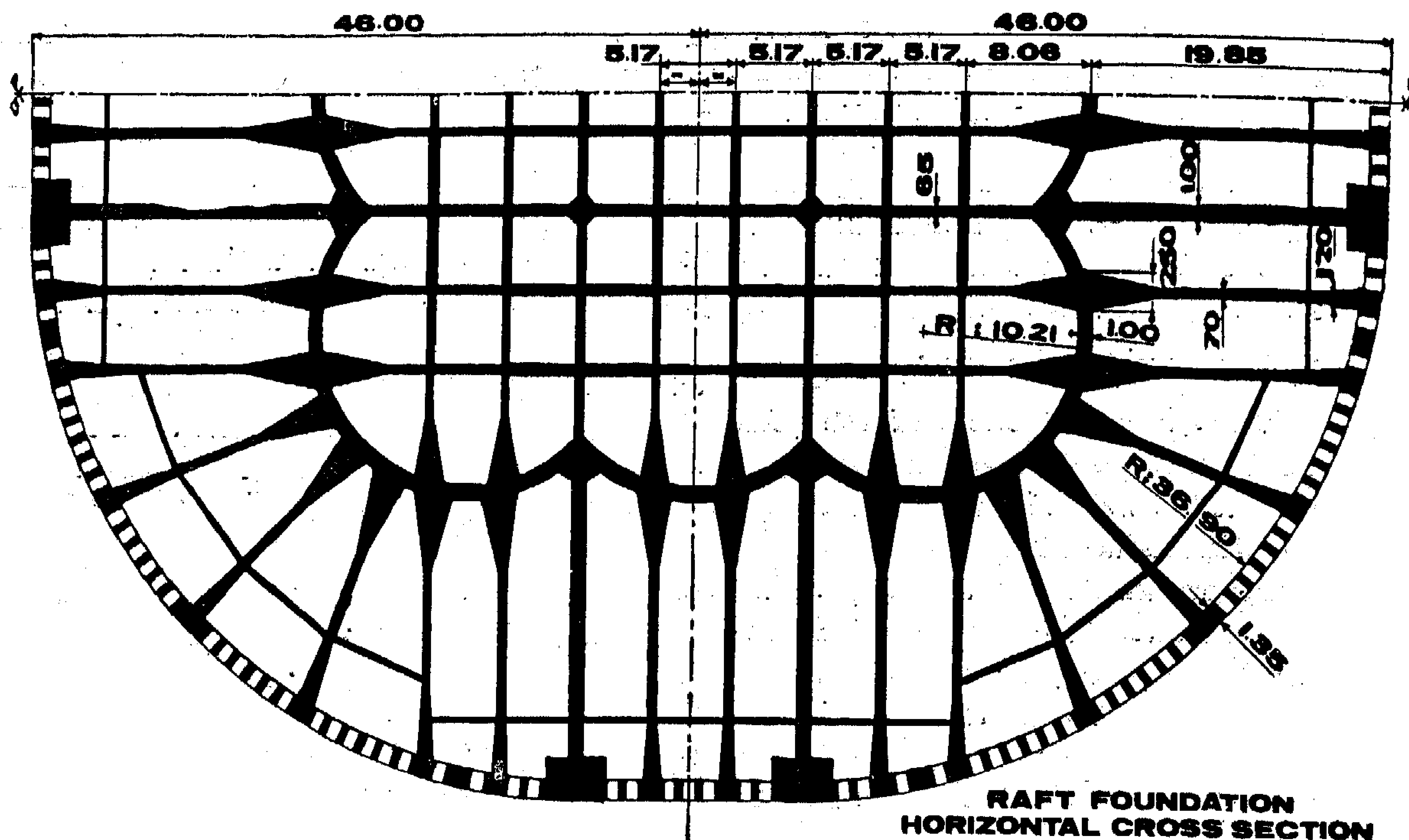
PERFORATED BREAKWATER WALL-

Thickness and perforation dimensions were defined by hydraulic considerations. It remained to find a suitable plan section leaving an inter-wall clearance of 20 m -optimum distance for wave energy dissipation- with minimal bracing back to the inner wall. Model studies have confirmed the undesirable nature of the interference caused by the bracing system which acts as a series of reflection screens.

The bracing system retained is simple a continuation of the orthogonal internal diaphragms from the reservoir compartment. The lower part, with few perforations, acts as a short deep cantilever where as the upper part, well perforated, is a simple strut system ensuring the equilibrium of horizontal forces. Thickness is uniform at 1,00m so as to permit slip-form construction.

Not being in contact with the crude oil, the breakwater wall has been designed in reinforced concrete. Prestressing cables have however been provided to assist resistance under the most severe loading conditions :

- Circumferential bables in the base section and in the top section which is subject to direct wave impact.
- Vertical cables from the base to level +36 designed to ensure transfer of vertical loads from the base (i.e. to ensure base-wall integrity under



less senitive to differential deflections by reducting the rib beam depth at the points of fixity on the innear wall : 3,50 m as against 6,00 m normal depth. This arrangement also has the advantage of relaxing the base firity of the inner wall. The required prestress has also been increased to allow for the unpredictable.

TANK WALLS —

The wall was proportioned so as to give approximately equal stress values in the internal diaphragms and in the cylindrical wall sections (e.g. compressive stresses due to an external pressure, while afloat, of the order of 60 t/m2 at the base; tensile stresses due to the maximum internal pressure, in service, of the order of 20 t/m2). This allows the points of fixity for any horizontal section

At the base the shape of the rib beams and the presence of the flexible slab at level +6 produce progressive fixity of the wall.

The stress situation is further improved while the struture is afloat in that the base itself is subject to high compressive stresses which reduce the differential deformations generating the fixity moments in the wall.

The base of the wall has however been thickened from 0, 50 m to 1, 00 m more for reasons of vertical load intensity than to accomodate fixity moments which are proportional to the wall stiffness.

This base section, serves as a distribution beam for the reactions from the various rib beams and forms the flange of the deep beam formed by the wall for carrying the vertical loads.

Similar problems, but with less intense loadings, exist at roof level where the structure is more flexible than at the base.

On the other hand, it is at the roof level that temperature effects are the most severe. The crude oil may be at a temperature of 44° C whereas the emerging reservoir wall may be cooled by an air temperature of -12° C.

Apart from the problem of weight limitation -maximum allowable draught is 64 m- the inner wall was designed to achieve the maximum possible flexibility (i.e. minimum possible thickness) in order to reduce the moments introduced by deformations due to thermal effects or interaction from adjoining structural elements.

turbulent pressure and the conservative part of the viscous shear stresses are involved in the dissipation process.

On the basis of an energy balance equation it has been shown that, in the case of a two dimensional structure, about 70 % of the total wave energy is dissipated in the chamber.

The "draw-in" effect of the perforations tends to decrease the wave reflection at the wall. The vertical velocity distribution induces near the surface a mass transport which is oriented, from the wall, in an outward direction. From the continuity principle a return flow is created near the bed which offers the advantage of reducing to a large extent, scouring effects at the toe of the structure.

4 - DESIGN CONSIDERATIONS

The specific problems posed by the structure result primarily from its size and from the lack of movement joints which creates an interaction between all structural elements. Deformations due to shear are comparable with those due to flexure and the magnitude of the loads means that effects normally qualified as secondary must be taken into account.

Also present are the classical problems of circular reservoirs fixed at the base and at the roof.

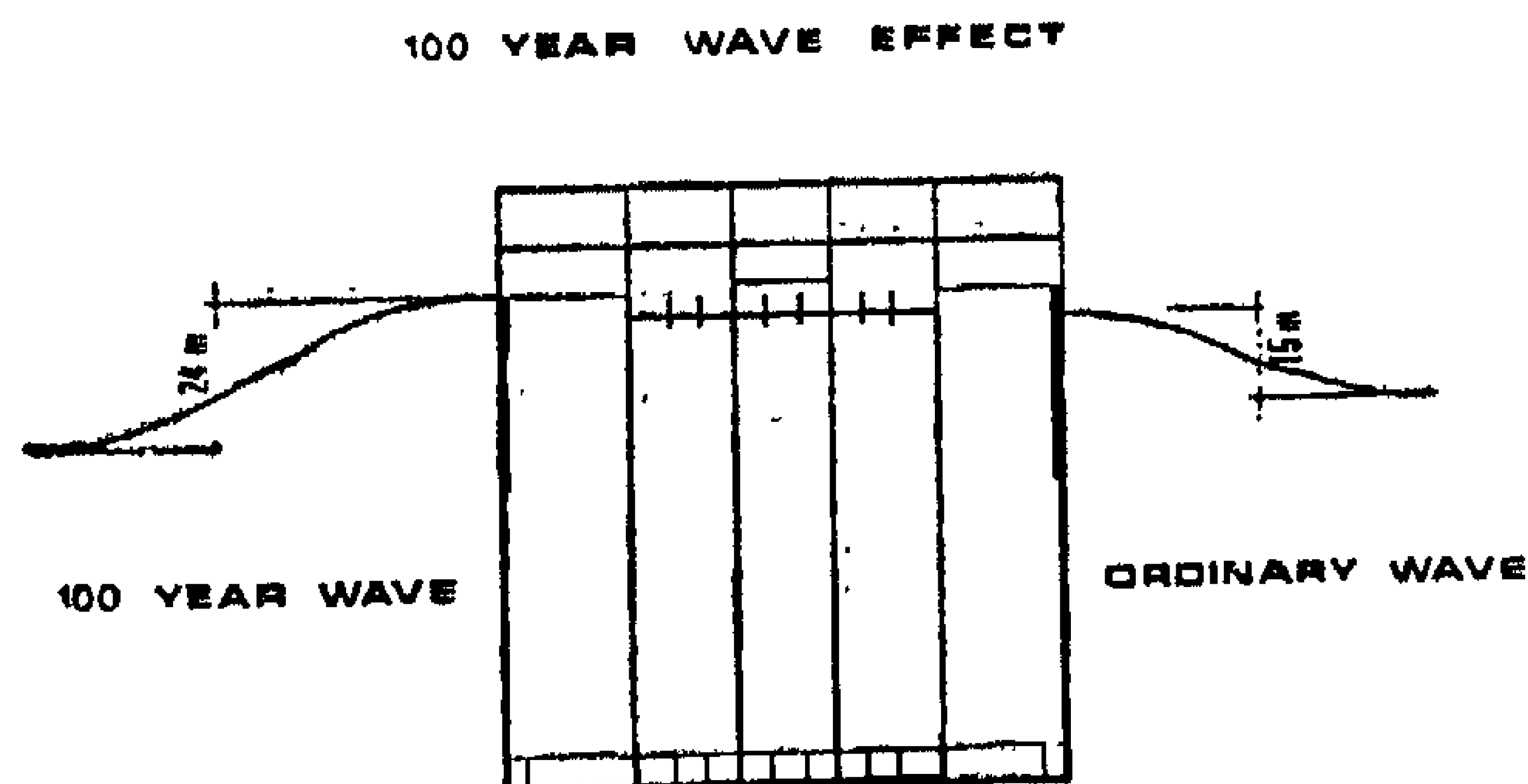
The tight planning schedule previously referred to did not permit the resolution of all the design problems before construction commenced. Also, the multiplicity of practical problems had to be accorded a certain priority.

The preliminary design was carried out by independant analysis of the different elements of the structure using close approach hypothese for the end conditions. This method has the advantage of clarity and the working drawings were prepared on this basis. An overall analysis -by large capacity computer- was subsequently called for but it was understood that even under the best possible conditions the results of this analysis would not be available before construction was well advanced.

RAFT FOUNDATION

This was designed as a beam-slab system loaded by linearly distributed foundation reactions and bearing on rigid supports formed by the walls and diaphragms. The design hypothese are debatable and thus further checks were made of :

- The behaviour of the slab sections between the rib beams when subjected to very high local foundation reactions. Note that these slabs were poured in two stages :
  - Stage 1 (60 cm) in the "dry dock", providing sufficient strength for the fist phase of reservoir construction (to level +36).
  - Stage 2, doubling this thickness, was carried out after leaving the "dry dock" so as to reduce the draught to a minimum for the exit operation.
- The behaviour of the rib beams under differential vertical deflection of the bearing walls and diaphragms -deflections difficult to estimate, par-
o.' the perforations.
ticularly for the outer wall because
The base structure has been rendered



2 - GENERAL OESCRIFTION OF THE PROJECT

The heavily-prestressed post tensioned caisson structure consists of the crude-oil reservoir itself -a slip formed nine-cell structure, somewhat similar to a grain silo measuring some 50 x 50 m in plan and rising 90 m from the base of the completed unit- surrounded by a perforated breakwater-wall (Jarlan patent) of mixed precast and in situ construction, nearly circular in plan with a mean diameter of 95m and joined to the reservoir structure by perforated slip-formed bracing walls which are effectively continuations of the tank structure's internal diaphragms. The reservoir and the perforated sea-wall are carried on a cellular raft foundation.

Once positioned on the sea-bed the caisson was anchored by its own weight plus the weight of its contents : there will be no additional anchorage. In order to maintain approximately constant negative buoyancy, the reservoir will be kept permanently filled, sea water being pumped in or out as the amount of oil being stored at any one time varies; sea water being pumped out of the tank will be passed through separators to remove any contaminating oil.

The tank will be used to store low sulphur crude oil with a specific gravity of 0.83.

Temperatüre from the separators to the tank is about 45° C. The filling rate is 350 000 BPD (2, 300 m30h) and the pump-out rate is 720,000 BPD (4,800 m3/h).

The storage compartments are always under pressure created by a water-tower located on the top of the tank. During the tank filling operation the oil coming from the production separators pushes out the seawater contained in the tank. Any residual oil in this water is removed and retained before the water returns to the sea. When oil is to be removed from the tank, seawater is pumped into the watertower and automatically replaces the oil pumped out of the tank. An internal piping installation allows sludge removal from the bottom of the tank by agitating and removing it with high pressure water jets.

A system of instruments continuously monitors and controls the oil-water interface in the tank. Other auxiliary equipment includes automatic venting, a fire-fighting system and required navigational sids.

The purpose of the perforated breakwater is to minimize the effects of loads induced by gravity liquid waves. When a wave impinges against the perforated wall, one part of the energy is reflected and the remainder goes through the perforations where the potential energy of the wave is transformed into kinetic energy (which is easier to dissipate). Because of the low reflection-coefficient of the obstacle, the differential pressure due to the wave is considerably smaller than is the case where it strikes a plain wall.

The kinetic energy inside the breakwater manifests itself as a jet which forms heat-dissipating eddies within the large fluid mass located between the perforated wall and the plain tankwall. Both

LOAD ON TOP OPERATION

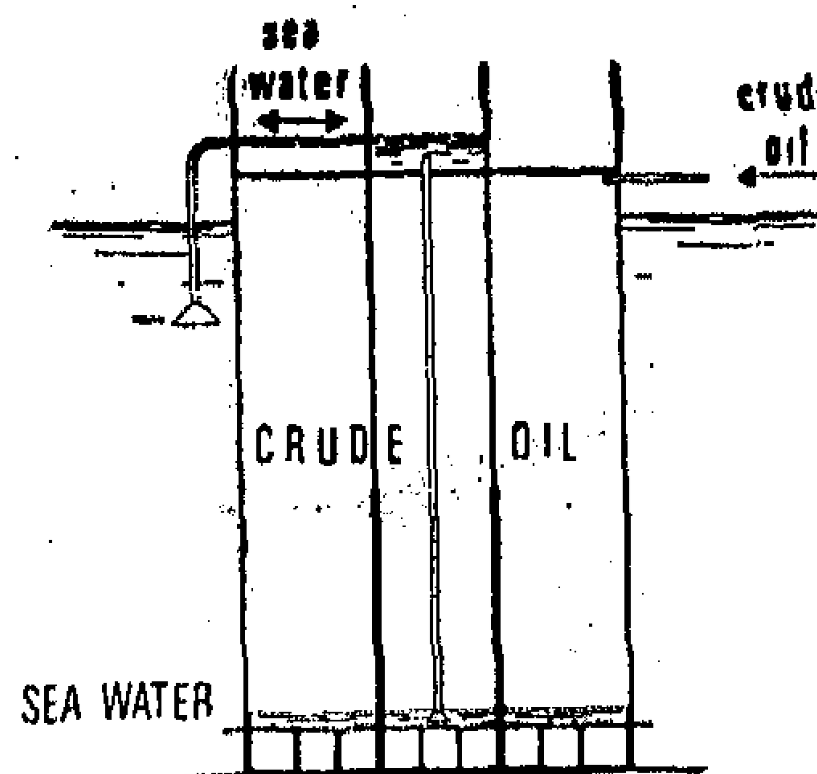
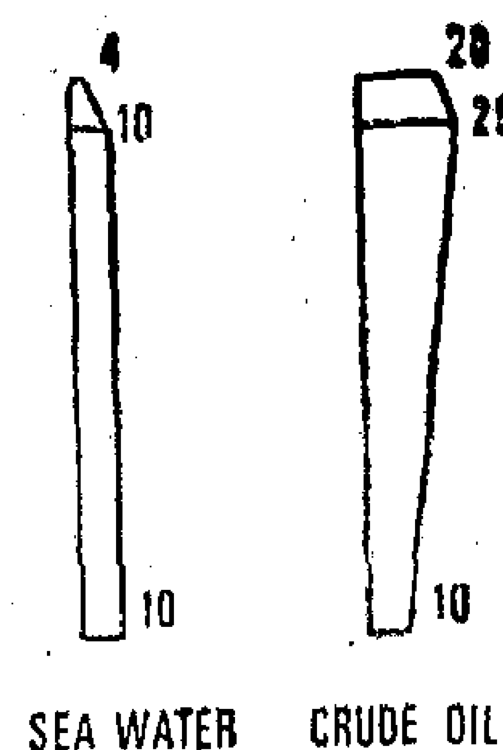
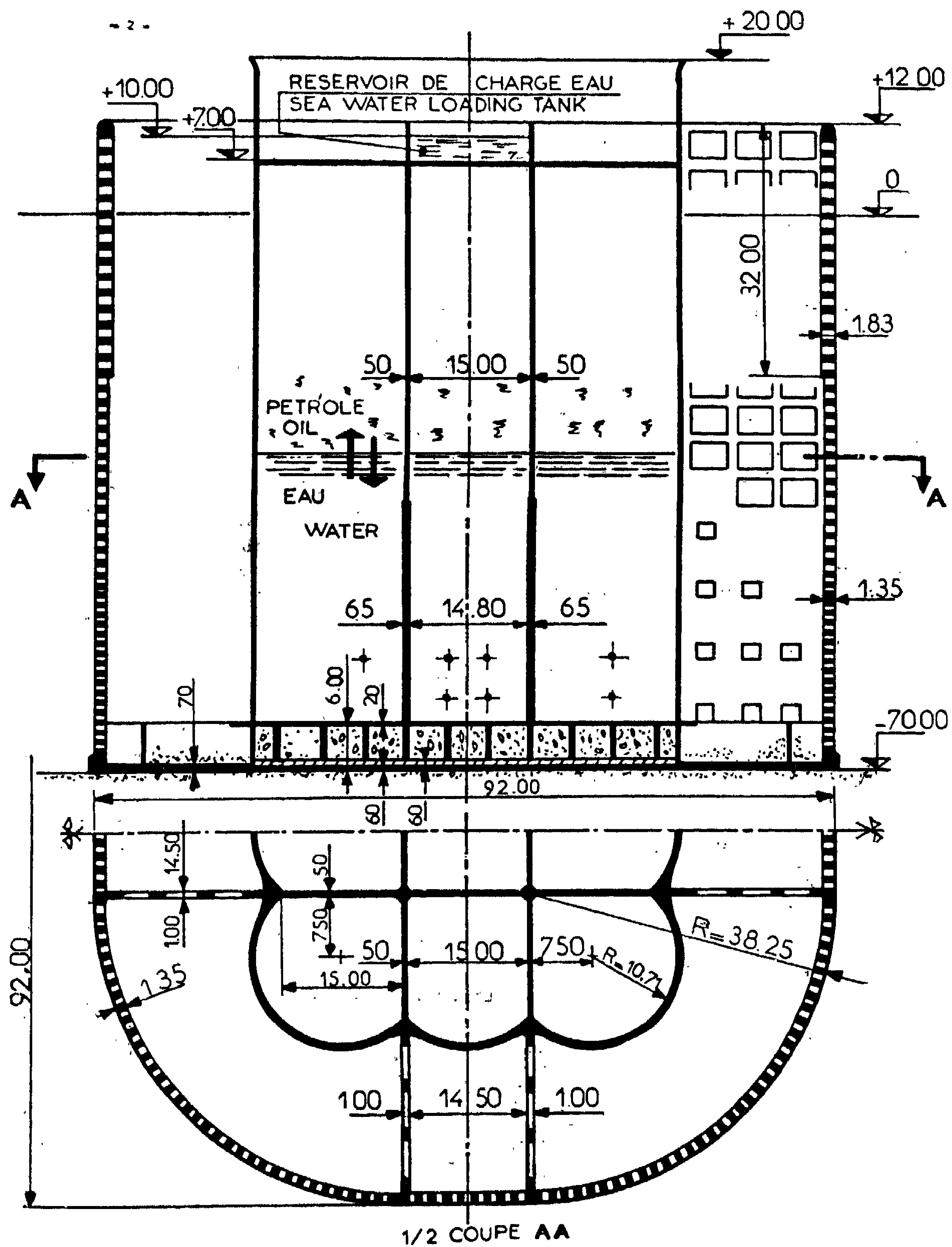


DIAGRAM OF FORCES T/M²





- 2 -
+ 20.00
RESERVOIR DE CHARGE EAU
SEA WATER LOADING TANK
+10.00
+7.00
+12.00
0
32.00
1.83
50
15.00
50
PETROLE
OIL
EAU
WATER
A
A
65
14.80
65
1.35
6.00
20
70
-70.00
92.00
80
80
14.50
50
1.00
7.50
50
15.00
7.50
R=10.71
R=38.25
15.00
1.35
92.00
1.00
14.50
1.00

1/2 COUPE AA

EKOFISK PRESTRESSED CONCRETE OIL STORAGE

BY

Dr. ING. G. NASSAR*

BASED ON THE LECTURE
DELIVERD

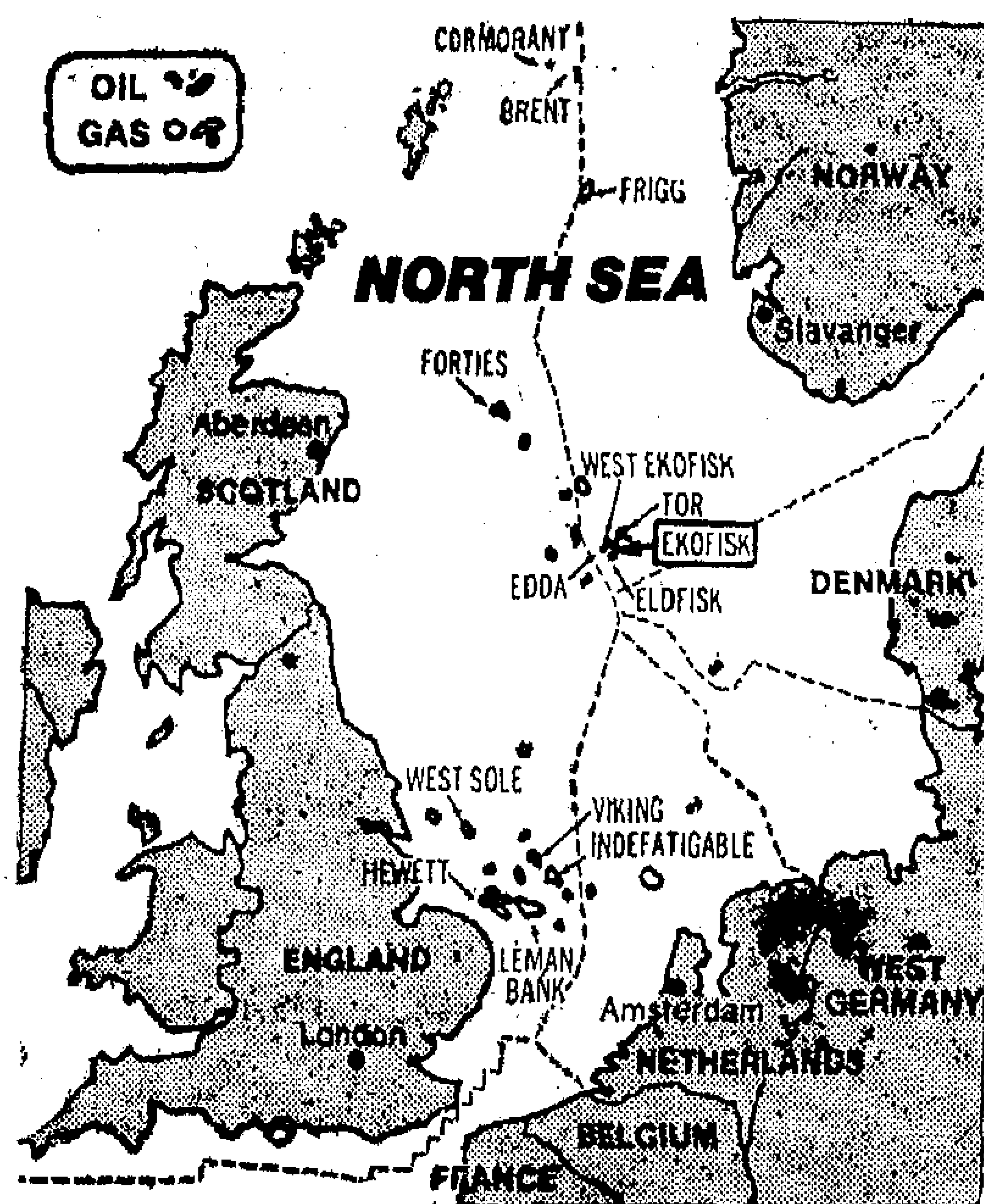
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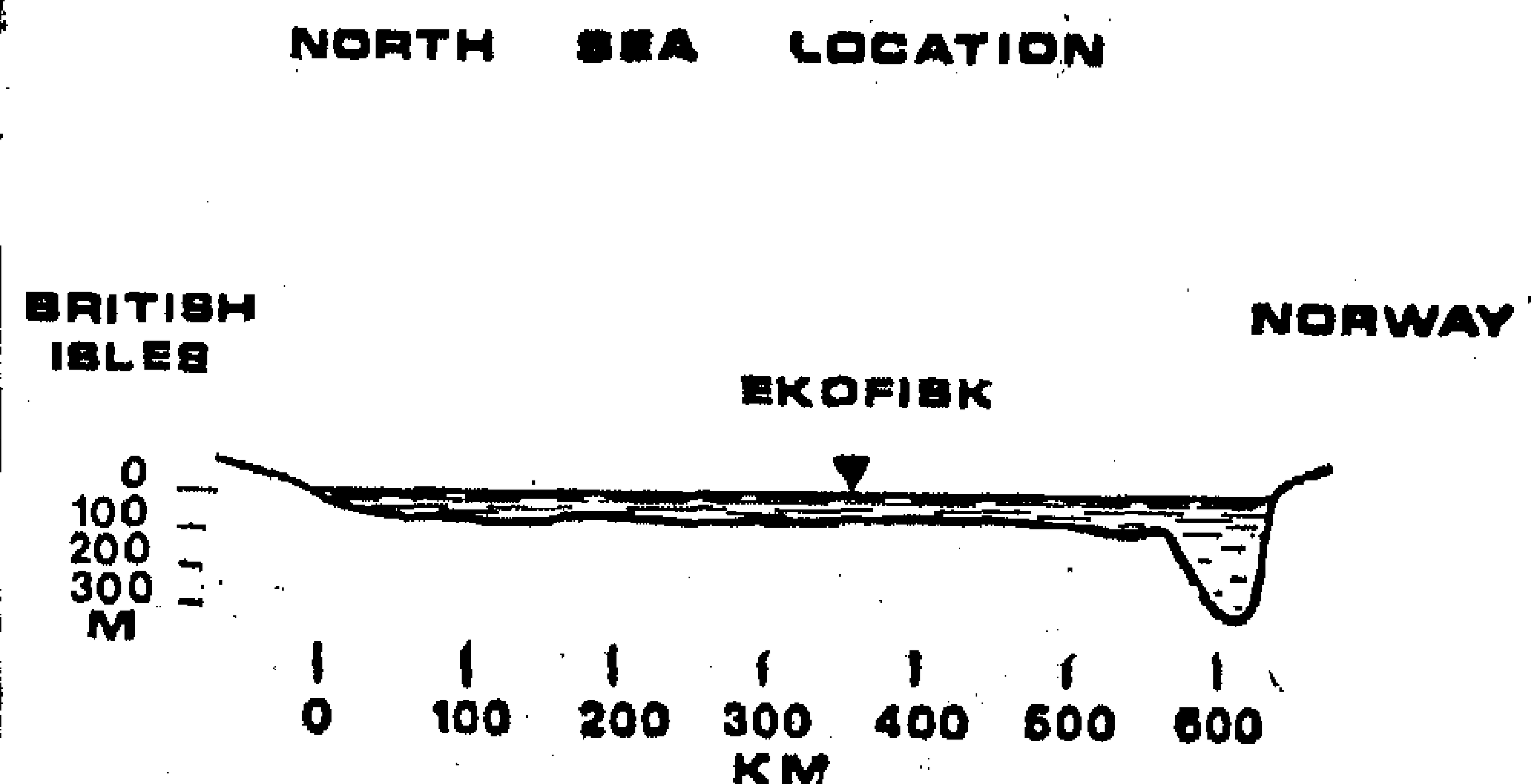
ENG. G. MAHFOUZ**

1 - INTRODUCTION

M prestressed concrete oil storage and tanker-loading caisson is completed for the North Sea's first commercial offshore oil operation, Production -initially 100 000 barrels/day- is expected to reach 300 000 barrels when the field is fully developed. Until a pipeline can be completed production output will be dependent on sea transport. The 125 000 tonne Ekofisk concrete "island" will rest on the sea bed in 70 m of water and have a storage capacity for up to 1 million barrels of crude oil, enough to maintain full production for up to three days when weather conditions prevent safe mooring of tankers.

At the tender stage, competitive designs were invited and both steel and concrete alternatives were proposed : with in situ construction ruled out by the distance from shore and the severe weather conditions of the North Sea, all of the designs considered involved building a virtually complete structure on the coast, then towing it to the site for sinking to the sea bed.





After a lecture delivered by Eng. G. MOHFOUZ (STUB), at the ESE.

Specialists from selected countries around the world expected to attend the December the world expected to attend the December national focus to an increasingly perplexing problem : how to house the growing population in the face of land shortages, material shortages, and energy shortages.

Indonesia Invites Joint Committee

Imagine a country of 3000 islands : (Yes, one of them is Bali.) 125 million people. It's surprising that a country so close to Singapore an d. Malaysia can have such different building conditions (foundation conditions, earthquakes)

Jakarta has a main axis runing south from the Java Sea harbor. The high-rise are spread along it. (One is led to think that someday a rapid transit system may find its way down the center of the fine, wide main street and provide some focusing of later ne wtall buildings). (An estimated 30 million people live). within a radius of 50 km).

The conference schedule? **December 9-11, 1974**, the week after Kuala Lumpur.

Honolulu Conference Date Set

Date : **January 26-29, 1975**

Theme : **Tall Buildings and the Growth of Cities.**

organizer : Art Chiu

(University of Hawaii)

Dr. G. NASSAR



banenko, Director of the USSR Research and Design Institute for Owellings.

Experts from various backgrounds and disciplines (developers, real estate interests, architects, designers, engineers and architects, designers, engineers and planners) will have the opportunity to examine public/private approaches to economc problems.

Papers are being invited by Professor Rubanenko. Scientific or review papers, case studies, possible solutions, are all acceptable. Due Date: Dec. 1974.

Date: **May/June 1975**

Place: **Prague,** Czechoslovakia

Conference Organizer: **Prof. B.Rubanenko,**
Research & Design Inst. for Dwellings,
Dmitroukoje Shosse 9, Moscow 1-434,
U.S.S.R.

LEBANON : MIDDLE EAST TALL BUILDING :

A topic touched on in past oJint Comittee conferences receives in-depth treatment in Beirut. Concerns include the rolo and their impact on cultural ttraaitions.
Date : 1975

Place : American UPniversity, Beirut
Conference Organizer :

Prof. Dr. **Jacques Nasser,** P.O. Box 2660, Beirut, Lebanon,

Major Themes :

. **Urban Plannnig.**

. **Construction Methods.**

. **Safety & Fire Protection.**

. **Limit States Design.**

EARTHQUAKES ON AGENDA AT BUDVA :

The (25th) tall building conference will probe the forces of earthquakes as they relate to construction. The week-long meeting runs concurrently with the Fifth Congress of the Yugoslac Association of Structural Engineers (a sponsor) and the Third Congress of the Asseociation for Earthquake Engineering.

Date : **September 30—October 5, 1974**

Place : **Budva,** Yugoslavia

Conference Organizer :

Professor **S. Bubnov.**

Dvorzkova 5, Ljubljana, Yugoslavia.

Major Themes :

. **Céiteria & loading**

. **Earthquake resistant design**

. **Construction (Steel & Concrete Bldgs)**

Malaysia Sets Conference Date

December 2-5, 1974. Session on a variety of topic are planned for December 2, 3,4. Wind loading and effects, fire safety economics, architecture and urban planning. December 5 is reserved for tours of the buildings that have very recently started to shoot skyward. Come to tapped— right at the edge of the city ! Hotels are going up as fast the office buildings. The Urban Development Authority puts 30 to 50% into «Joint Ventures» with private developers.

Singapore : Hi-Rise Housing Workshop

Immediately following the Kuala Lumpur Conference iwll be : «Workshop on Hi-Rise Housing : A World-Wide Review» **December 6 & 7, 1974.** Theyve dealt remarkably well with high-rise housing. And that's mainly because they seem to have planned for **living.** Cultural constraints have been considered in their designs. Population economy seems vigorous. There is a surprising amount of green space in this 200 — square-mile island country.

tion of the steering group, led by Mr. Duliu Sfintesco.

Such arrangements are established by UNESCO, to enable it "to secure documentation, advice, and technical cooperation from international non-governmental organizations and, on the other, for that of enabling organizations which represent important sections of public opinion to express the views of their members... thus increasing international cooperation in the fields of education, science, and culture".

OXFORD EXAMINE SOCIAL EFFECTS:

Most historians link the growth of cities to the beginning of the Industrial Revolution. Hardly a more appropriate setting could be found, then, to discuss "Tall Buildings and People" than Britain, birthplace of the Machine Age and one of the world's most densely populated countries.

The fall conference, sponsored by the British Group of IABSE and the Institution of Structural Engineers, is to cover a variety of social issues raised by the tall building environment. The very question of high-rise justification will be aired as part of the multidsciplinary study.

Plan to attend an benefit from the British bckground of experience in urban concentration.

Date: **September 17-19, 1974**

Place: St. Catherine's College, Oxford

Contact: **Mr. R. J. W. Milne,** Secretary-IABSE, 11 Upper Belgrave St., London SWIX 8 BH, Great Britain

MEMBERSHIP STATICS :

Members	1060
Committees	58
Countries	52
Liaison Organization Members	60
Cities	497

REGIONAL CONFERENCES :

Note the following new and revised dates (beyond those that appear elsewhere in this issue):

— Dec 2- 5,'74 Malaysia: Kuala Lampur A. Rahulan

— Dec 6, '74 (tour) Singapore L. Au, B. Lim

— Dec 9-11, 74 Indonesia: **Jakarta** R. Roosseno, A. Karthahardja

— Jan 26-29, '75 U.S.A., **Honolulu** A. Chiu

— May 15-17, '75 Hungary: **Budapest** B. Goschy

— Oct 2- 3, '75 German Fed. Rep: **Mainz F. Reinitzhuber**

— Oct 7- 9, '75 Greece: **Athens** B. Vavaroutas

The previously scheduled Lebanon Conference is deferred to 1975.

Fire Safety :

"The Sears Tower in Chicago, the world's tallest building and one of 11 projects nominated for the 1974 ASCE Outstanding Civil Enginering Achievement Award, has a fire-safety system date for a high-rise building. The system includes automatic sprinklers, computericonsidered one of the most complete to zed smoke detectors, fans to exhaust smoke, and pumps for firefighting water at several levels".

...ASCE

SYMPOSIUM II PLANNED FOR PRAGUE :

Eastern and Western schools of economic thought will join in discussion of the upcoming meeting of CIB's Commission S41 in May, 1975 on the theme: "Tall Buildings: A Technico-Economic Evaluation". "S41" is chaired by Prof. B. Ru-

(b) **Associated Opportunities**

It is expected that the Conference Week will attract as many as 150 specialists from all parts of the world — about 30 of these specialists will attend with separate financial support. Such a concentration of expertise will be unprecedented, and will be fully utilized in the following ways :

1. the experts will present lectures at the plenary sessions.
2. they will participate in the workshops relevant sessions.
3. they will be available to give advice to practical problems which exist either within Egypt or elsewhere in the world.
4. they will be available to give special lectures in Cairo outside the framework of the Conference.

In addition, invitations to attend the conference will be sent to selec- UNESCO specialists.

G. NASSER

TALL BUILDINGS AND ENERGY :

There areeso many ways to save energy. Are you using them? Some of the latest "tips" are contained in NBS' DIMENSIONS of March, 1974.

The Hindustan Times (India) editoties in metropolitan centers... The horirialized at the time of the 8th Regional Conference (Jan. '73) that :

"after a certain point there is no alternative to the vertical expansion of cizontal spread of cities calls for infrastructural utilities such as roads, sewerage, water supply, electrical and telephone lines, bus services, and the rest which use large quantities of construction material, not to mention the huge investments on land and civic services."

And the automobile? In the USA it accounts for 12% of the energy consumption.

Possibly we should watch for a number of trends that have significant energyconservation potential and that, indeed, are actively pursued in number of regions already:

— Construction of hi-rise housing amidst commercial buildings in urban centers (maybe we can walk to work).

— New "cities within cities" that will feature this same mix (at sites of needed urban renewal).

— The containment of the perimeter of growing cities through utilization of use twice as much energy per pervertical space ("low density suburbs as cities" ... Lewis).

— The concentration of housing decentralization in more tall apartment buildings (This will help mke mass transit more economical - and attractive. Also it will decrease dependence on the automobile).

UNESCO ADMITS JOINT COMMITTEE

Word is received that the Joint Committee has been admitted to UNESCO as a non-governmental organization, Category C ("mutual information relationship"). This brings to fruition the initia-

TALL BUILDING NEWS:

Prepared by : G. Nassar

LEHIGH PLANS A NEW CONFERENCE ON HOUSING IN DEVELOPING COUNTRIES IN CAIRO, JANUARY 1975

It is proposed to hold a Three-Part Conference within the period 6 to 11, January, 1975, in Cairo, Egypt, on the general theme of :

Housing in Developing Countries — The Role of Tall Buildings — Low Cost Housing — Planning and Environmental Criteria.

(a) **Purpose of the Conference**

The exploding population in developing countries has created an urgent need for housing, housing which must be **economic yet human, safe yet compact, livable yet socially acceptable.** Increasing consideration is being given to the role of tall building in filling these needs. Yet, the tall building introduces its own effects, and these must be considered with the end objective in view.

The emphasis is given to «housing» for a number of reasons. First it is such an urgent need in so much of the world. Second, both economic and energy conservation reasons require a consideration of hi-rise housing. Third, the rapid increase in population coupled with disapearing agricultural land (precious arable land is being rapidly absorbed by low-density suburbs) strongly points to more «vertical living» in the future.

The phases involved in the development of such housing may be broken down into three distinct yet related parts — it is these three parts which form the topics of the conference, as outlined. Each part of the conference will be an entity unto itself, but because of the inter-related nature of the whole problem, it is highly advantageous to have the proposed scheduling of the separate parts of the conference will achieve this aim.

Each part will last about three days, and will include one plenary session where prepared pjapers will be presented, summarizing the needs and the possible solutions, and a workshop lasting two days where each separate topic will be discussed by relatively small groups of specialists.

The three parts iwll overlap to a slight extent, and will take place within the week of 6 11 January 1975 in Cairo, Egypt. It is is planned to have essentially continuos workshops with the will allow both the desired interaction between various specialists, as well as the as the possibility of attendance at the plenary sessions and workshops.

حول تجربة تحميل الأسقف الخرسانية
ومدى دقتها فى تحديد جودة الخرسانة

للدكتور عبد الفتاح أبو العيد
الأستاذ المساعد بجامعة القاهرة

والدكتور حسن طه العروسى
المدرس بجامعة الأزهر

١ ـ مقدمة

كثيرا ما تكون نوعية الخرسانة ـ بعد اقامة المنشأ ـ موضع خلاف بين المصمم والقائمين على عملية التنفيذ ، وتستخدم فى هذه الحالة الطرق المختلفة للاختبارات غير المتلفة للتعرف على مدى جودة الخرسانة المستخدمة فى المنشأ : مثل طرق الاختبار بالاشعاعات Radioactive Methods للتعرف على الشروخ والفرغات التى يحتويها الجسم الخرسانى عن طريق اختراق الأشعة للجسم وفحص تأثير هذه الشروخ على شدة الأشعة المستقبلة على فيلم حساس يوضع على الجانب الآخر من الجسم الخرسانى . كذلك تستخدم بكثرة اختبارات صلادة الجسم الخرسانى Hardness Methods بطريقة احداث علامة Indentation Method وطريقة الارتداد Rebound Hammer حيث تتناسب مقاومة ضغط الخرسانة عكسيا مع حدوث علامة بسطح الخرسانة وطرديا مع رقم الارتداد المقروء على المطرقة مثل مطرقة شميدت Schmidt Hammer كذلك يمكن التعرف على سلامة الخرسانة عن طريق الرنين باستخدام الموجات الصوتية أو فوق الصوتية ، كذلك تستخدم الاهتزازات الكهربائية الديناميكية للعينة لتحديد معاير المرونة الديناميكى للخرسانة Edyn الذى تتوقف قيمته الى حد كبير على نسبة الفراغات بالخرسانة وبالتالى على مقاومة الخرسانة للضغط والانحناء .

ومن الطرق التى يعتد بها فى فحص نوعية الخرسانة فى المنشآت ، اختبار مقاومة ضغط الخرسانة الفعلى على عينات أسطوانية مستخرجة من بعض مواضع المنشآت . . الا أن الطريقة المثلى لدى الكثير من المهندسين هى طريقة اجراء عملية تحميل المنشآت الخرسانية وخصوصا البلاطات والجسور كفحص نهائى يتوقف عليه البت فى مدى جودة الخرسانة ، اعتمادا على ما يحدثه الحمل المؤثر فى البلاطة من ترخيم Deflection يؤخذ كمقياس لتحديد نوعية الخرسانة والموافقة على جودتها طالما وقع مقاس الترخيم فى الحدود المسموح بها فى الاشتراطات التصميمية والمواصفات .

٢ ـ من الخبرة مع اختبار التحميل :

اجريت فى محطة الأبحاث الحكومية بدولة الكويت تجربة التحميل على بلاطة خرسانية ابعادها ٦٫٠٠ متر × ٣٫٠٠ متر × ١٠ سم ، فكان مقاس الترخيم لها تحت الحمل التصميمى = ٢ ملم وتبين أن هذه القيمة اقل بكثير مما تسمح به المواصفات الأمريكية ، ولما اجرى اختبار الضغط على اسطوانات مستخرجة من نفس البلاطة تبين أن مقاومتها للضغط فى المتوسط = ٣٩ كجم/سم٢

ولما كان من الشائع لدى جمهور المهندسين اللجوء الى تجربة تحميل الأسقف الخرسانية كفيصل فى الحكم على جودة الخرسانة وقبولها طالما وقع مقاس الترخيم للسقف فى حدود ما تسمح به المواصفات ، فقد لزم التنويه الى خطأ هذه النظرية فى البحث المعروض .

٣ ـ مقاس الترخيم وعلاقته بالخواص التكنولوجية والهندسية للأسقف الخرسانية :

اذا تساوت الأبعاد لمجموعة من الأسقف الخرسانية واختلفت فقط جودة الخرسانة المستخدمة فى كل منها ثم أجريت عليها تجربة اختبار الترخيم بتحميلها احمالا متساوية فان مقاس الترخيم .

$$Y = \frac{K}{E} \qquad (1)$$

حيث Y = مقاس الترخيم تحت الحمل المؤثر ،
K = دالة تحتوى على معامل حسابى ثم كثافة التحميل وقيم هندسية للبلاطة (طول العضو الخرسانى وعزم القصور الذاتى له)
E = معاير مرونة الخرسانة .

ومن هذه المعادلة نرى أن مقياس الترخيم لجميع البلاطات يتناسب عكسيا مع معاير مرونة الخرسانة فقط طالما تساوت أبعادها وكثافة التحميل عليها ، أى أن معاير المرونة فى هذه الحالة هو المحدد لأساس التفضيل بين الأسقف فيما لو اتخذ مقياس الترخيم حكما فى تحديد جودة الخرسانة ، لذلك ، يجب تدارس العلاقة بين معاير المرونة. ومقاومة الضغط فى الخرسانة للتعرف على مدى صحة هذه النظرية بالنسبة للبلاطات الخرسانية .

٤ ـ العلاقة بين معاير المرونة ومقاومة ضغط الخرسانة :

يبين الجدولان (١) ، (٢) العلاقة بين عمر الخرسانة وكل من مقاومة الضغط ومعاير المرونة لخمس خلطات خرسانية مختلفة التركيب ، وذلك بعد ٣ و ٧ و ٢٨ يوما ثم بعد ثلاثة أشهر وسنة واحدة وخمس سنوات من صبها (*) .

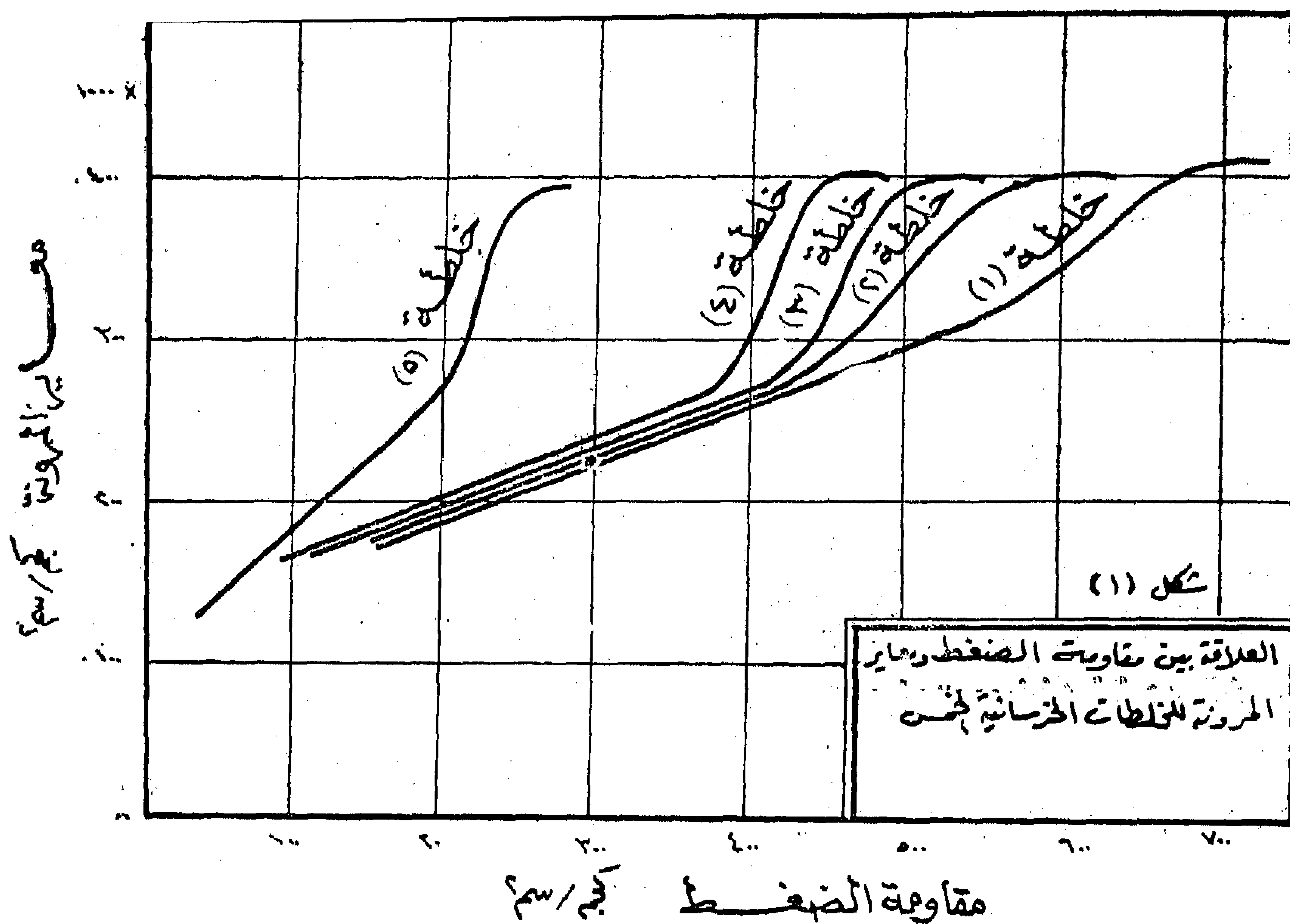
كذلك توضح المنحنيات بالشكل رقم (١) العلاقة بين مقاومة الضغط ومعاير المرونة لهذه الخرسانات

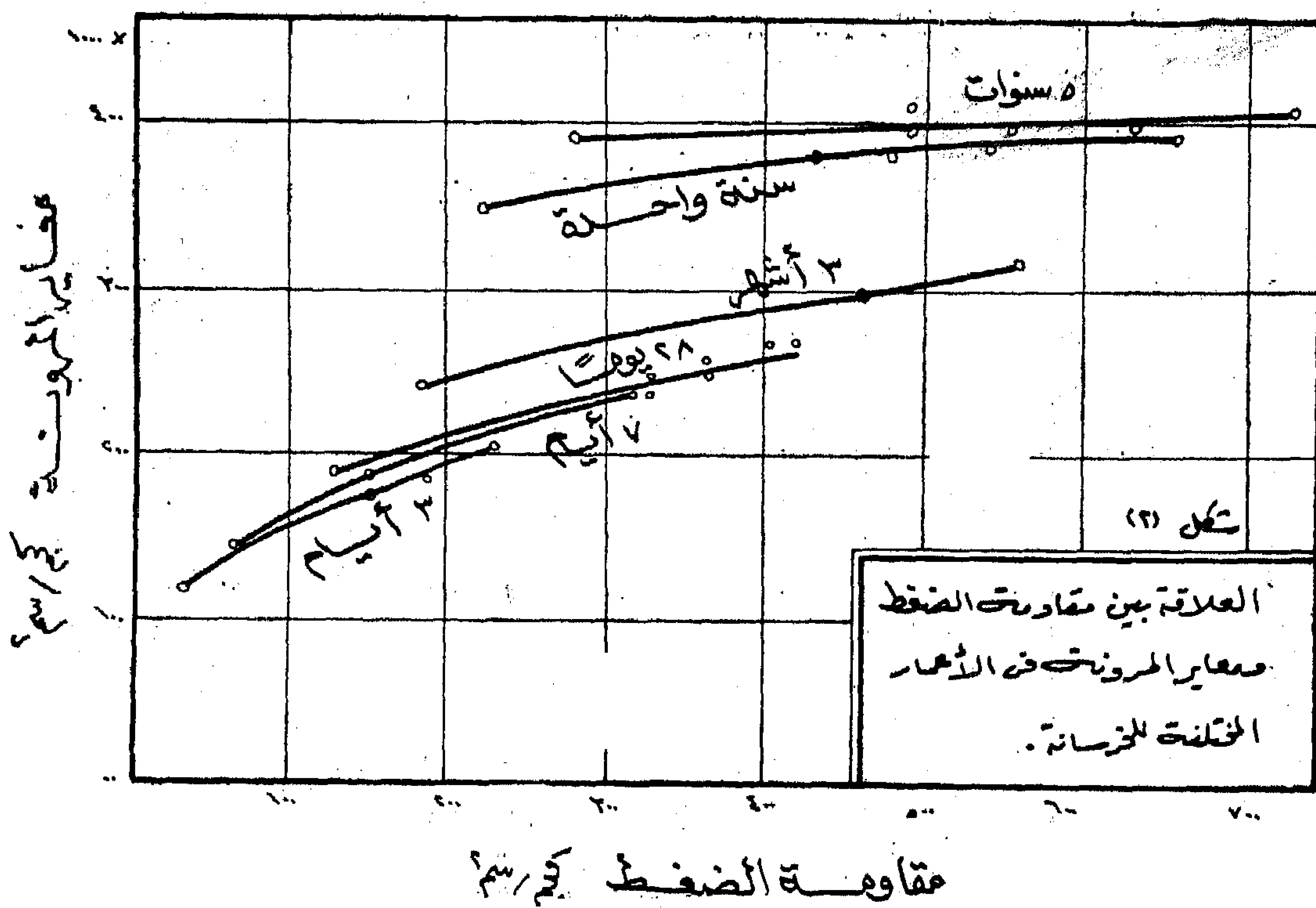
جدول رقم (١) : تطور مقاومة الضغط بالنسبة للزمن للخلطات الخرسانية الخمس

نوع الخلطة الخرسانية	مقاومة الضغط كجم/سم٢ بعد :					
	٣ أيام	٧ أيام	٢٨ يوم	٣ شهور	سنة واحدة	خمس سنوات
١	٢٢٦	٣٢٧	٤١٩	٥٤٩	٦٤٥	٧١٤
٢	١٥٢	٢٢٨	٣٦١	٤٥٧	٥٣٢	٦٢٠
٣	١١٠	١٨٤	٣١٤	٤٠١	٤٧٢	٥٤٥
٤	٩٤	١٤٩٪	٢٤٧	٣٦١	٤٢٣	٤٨٢
٥	٣٤	٦٦	١٢٢	١٧٩	٢٢١	٢٧٦

جدول رقم (٢) : تطور معاير المرونة بالنسبة للزمن للخلطات الخرسانية الخمس

نوع الخلطة الخرسانية	معاير المرونة كجم / سم٢ بعد :					
	٣ أيام	٧ أيام	٢٨ يوم	٣ شهور	سنة واحدة	خمس سنوات
١	٢٠٢٠٠٠	٢٣٥٠٠٠	٢٦٥٠٠٠	٣١٤٠٠٠	٣٨٩٠٠٠	٤٠٤٠٠٠
٢	١٧٥٠٠٠	٢٠٦٠٠٠	٢٤٥٠٠٠	٢٩٥٠٠٠	٣٨٠٠٠٠	٣٩٧٠٠٠
٣	١٦٢٠٠٠	١٨٧٠٠٠	٢٣٥٠٠٠	٢٦٣٠٠٠	٣٧٥٠٠٠	٣٩٢٠٠٠
٤	١٥٧٠٠٠	١٨٢٠٠٠	٢٢٠٠٠٠	٢٥٤٠٠٠	٣٧٥٠٠٠	٣٩١٠٠٠
٥	١٢٠٠٠٠	١٤٠٠٠٠	١٩٥٠٠٠	٢٤٠٠٠٠	٣٤٩٠٠٠	٣٨٩٠٠٠


معاير المرونة كجم/سم٢
× ١٠٠٠
٤٠٠
٣٠٠
٢٠٠
١٠٠
خلطة (٥)
خلطة (٤)
خلطة (٣)
خلطة (٢)
خلطة (١)
شكل (١)
العلاقة بين مقاومة الضغط ومعاير المرونة للخلطات الخرسانية الخمس
١٠٠ ٢٠٠ ٣٠٠ ٤٠٠ ٥٠٠ ٦٠٠ ٧٠٠
مقاومة الضغط كجم/سم٢


معاير المرونة كجم/سم٢
× ١٠٠٠
٤٠٠
٣٠٠
٢٠٠
١٠٠
٥ سنوات
سنة واحدة
٣ أشهر
٢٨ يوما
٧ أيام
٣ أيام
شكل (٢)
العلاقة بين مقاومة الضغط ومعاير المرونة فى الأعمار المختلفة للخرسانة.
١٠٠ ٢٠٠ ٣٠٠ ٤٠٠ ٥٠٠ ٦٠٠ ٧٠٠
مقاومة الضغط كجم/سم٢

فى اعمارها المختلفة ، اما الشكل رقم (٢) فيبين العلاقة بين مقاومة الضغط ومعاير المرونة بالنسبة للزمن للأنواع المختلفة من الخلطات الخرسانية .

وبالرجوع الى أرقام الجدولين (١) و (٢) يتضح ــ بصورة عامة ــ أن معدلات زيادة مقاومة الضغط للخرسانة لا تقابل بزيادة فى نفس المعدل بالنسبة لمعاير المرونة لها ، فبالنسبة للخرسانة فى اعمارها المبكرة (بعد ٢٨ يوما مثلا) يلاحظ أن مقاومة الضغط لخلطة الخرسانة رقم (١) بلغت ٤١٩ كجم / سم٢ ، وللخلطة رقم (٥) بلغت ١٢٢ كجم / سم٢ ، والنسبة بين هاتين القيمتين = ٣ر٤٤ ، وبحساب النسبة بين معاير المرونة لكلا الخلطتين (أعلا جودة واقل جودة فى الخمس خلطات) نجدها =

$$\frac{٢١٠ \times ١٩٥}{٢١٠ \times ٢٦٥} = ١ر٣٦$$

اما فى الأعمار المتقدمة (بعد خمس سنوات من الصب) فبحساب النسبة بين معاير المرونة لأجود أنواع الخرسانة (الخلطة رقم ١) وأقل الخلطات جودة (الخلطة رقم ٥) يتبين انها لا تتعدى ١ر٠٤ فى حين ان النسبة بين مقاومات الضغط لكلا النوعين بلغت ٢ر٥٩ بعد خمس سنوات من صبها (انظر منحنيات الشكل رقم ٢) .

٥ ــ علاقة مقاس الترخيم بكل من معاير المرونة ومقاومة ضغط الخرسانة :

بناء على ما تقدم وتطبيقا للمعادلة رقم (١) نجد أنه عند تحميل سقفين لهما نفس الأبعاد بنفس كثافة التحميل ويختلفان فقط فى نوع الخرسانة (الخلطة (١) والخلطة (٥) مثلا) فان مقاس الترخيم Y للسقف من نوع الخرسانة (٥) الضعيفة لا يزيد عن ١ر٣٦ فقط من مقدار الترخيم Y المقاس للسقف ذى الخرسانة القوية (١) ، فى حين أن مقاومة الضغط للخرسانة القوية = ٣ر٤٤ مرة قدر مقاومة الخرسانة الضعيفة .

وعلى ذلك فانه لو نصت الاشتراطات التصميمية للمنشأ على ضرورة استخدام خرسانة جيدة من النوع (١) واستبدلها المنفذون بالنوع (٥) ، فان تجربة التحميل لكلا السقفين لن تعطى حكما مؤكدا على نوعية الخرسانة وذلك لأن النسبة بين مقاومة الضغط ــ وهى المحددة فعلا لنوعية الخرسانة ــ والقيمة المقاسة للترخيم تصل الى ٢ر٦ .

هذا فيما لو أجرى اختبار التحميل فى الأعمار المبكرة (٢٨ يوما) من صب الخرسانة ، أما لو أجرى الاختبار بعد خمس سنوات على كل من السقفين المصنوعين من الخرسانتين (١) و (٥) فان مقاس الترخيم فى كل سوف يعطى نفس القيمة تقريبا على الرغم من أن النسبة بين مقاومة الضغط للخرسانة الجيدة وتلك للخرسانة الضعيفة = ٢ر٥٩ .

هذا ويجب ألا يفوتنا هنا أن نذكر ان الأرقام الخاصة بمقاومة الضغط ومعاير المرونة أرقام لخرسانات عولجت معمليا ، أما عن الخرسانات المعرضة للأحوال الجوية العادية فمن الطبيعى حدوث تغير قليل فى النتائج حيث لا توجد درجة الرطوبة الكافية لاستمرارية تفاعل الأسمنت وبالتالى فسوف تتأثر نتائج كل من معاير المرونة ومقاومة الضغط بذلك ، الا أن هذا التغيير يتوقع أن يكون متوازيا . وللتعرف على هذه التأثيرات فاننا نجرى حاليا بعض الدراسات لتحديد العلاقة بين هاتين الخاصتين تحت الظروف الجوية العادية .

٦ ــ الخلاصة :

مما سبق يتبين أن مقاس الترخيم فى الأسقف والأعضاء الخرسانية الناشىء عن تجربة تحميلها لا يتأثر بمقاومة ضغط الخرسانة بالصورة التى تجعل من تجربة التحميل وبالتالى مقاس الترخيم فيصلا فى الحكم على نوعية الخرسانة وجودتها ، بل ويقع مقاس الترخيم فى كثير من الأحيان فى الحدود التى تسمح بها الاشتراطات ، وذلك لأن معاير المرونة للخرسانة لا يتأثر بصورة كبيرة بجودة الخرسانة ، ويتلاشى هذا التأثير تقريبا فى الأعمار المتقدمة .

٧ ــ المراجع :

(*) Engineering Materials Handbook — Author Mantell (Mc Graw-Hill) P. 24 / 31.

5. CONCLUSIONS

The Building (Fifth Amendment) Regulations are less restrictive than was at first thought. While virtually complete framing was thought to be necessary in 1968 by 1971 a design providing occasional vertical posts and some composite beams could readily comply. In future it is likely that with reasonably cellular plan forms only horizontal continuity of floors will be required.

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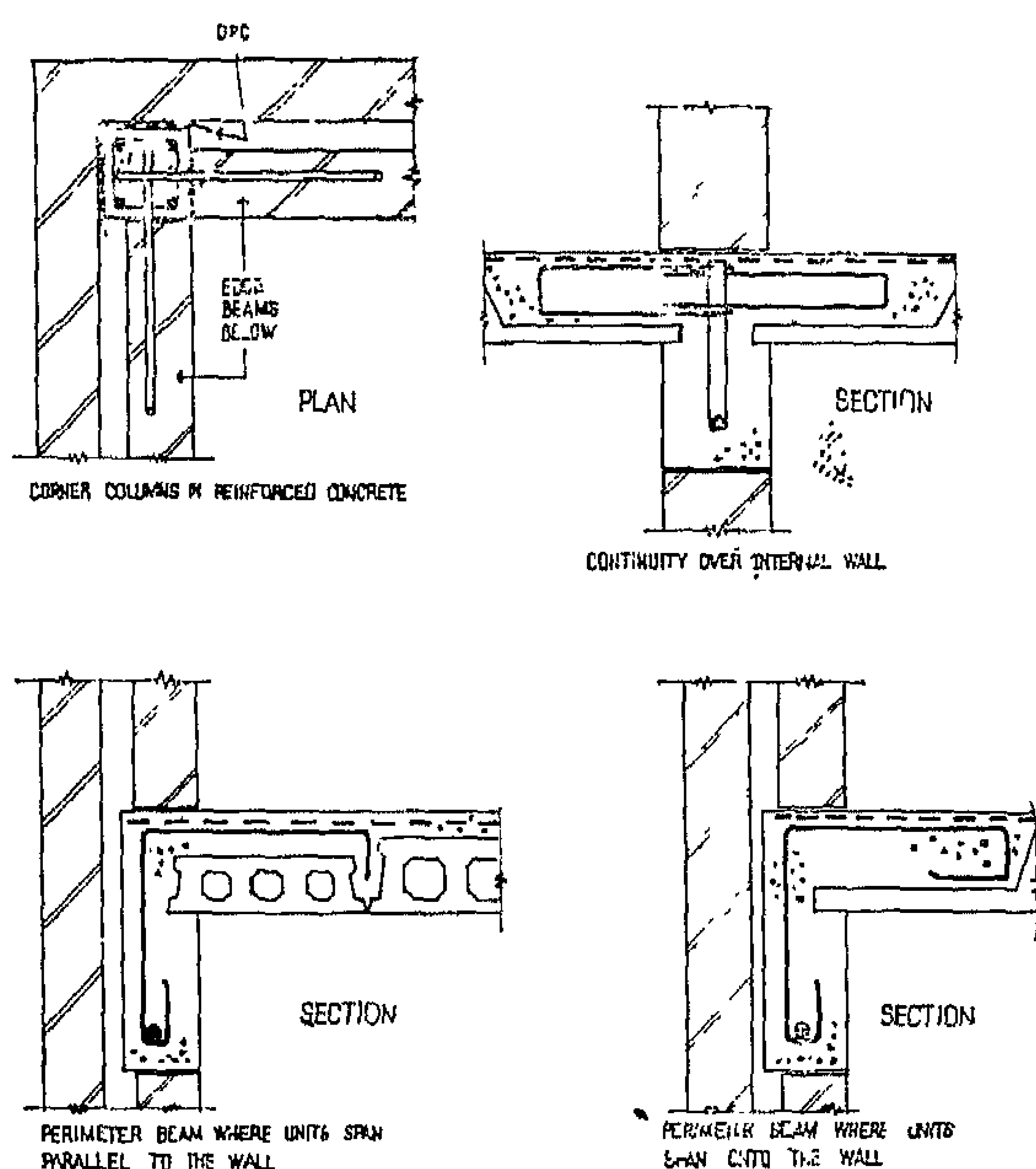


Figure 5—Types of support provided against progressive collapse at King's Park.

demonstrated and further research is proceeding. A valuable area for further development would be on the arching of walls for varying spans with varying degrees of lateral restraint. It may be assumed that the present wall length of 2.25 x wall height is devised from empirical rules of arching action but the figure is somewhat arbitrary since no account taken of variation in vertical loading.

A matter of continuing debate is the selection of suitable floor systems. In broad terms the choices are-

1. in situ slabs spanning in two directions.
2. wide precast slabs with an in situ topping spanning in one or two directions.
3. precast units spanning in one direction.
4. prestressed units with or without filler blocks spanning in one direction.

In a purely structural sense there is little to choose between in situ slabs and those with thin precast soffit units. Each will generate plate action under general load and can easily carry horizontal forces both tensile and compressive. Furthermore their fracture patterns are gradual and load shedding, and catenary action can be expected. The value of catenary action, however, has still to be demonstrated convincingly.

Cost must enter into the equation and largely because of their fast speed of erection, precast and prestressed precast units become attractive. A structural screed is needed in order to provide cover for the reinforcement to carry direct forces at right angles to the direction of span. Such screeds defeat the current trend to prefabrication and cause problems with brick coursing. As an alternative some post-tensioning would be effctive although it introduces yet another site trade. A major problem is connection between the units, particularly where they meet over narrow cross walls or where the span direction changes at a wall position.

The largest factor in the cost increases of frameless buildings is the use of downstand beams when these are thought to be necessary. Some attempts have been made to use precast beams but longitudinal jointing inhibits such systems. An alternative could be the production of thin sectioned U-shaped ceramic blocks. These would be two courses high and laid at the top of a wall with their open ends uppermost to act as permanent shuttering for anti-collapse beams. Normal brickwork can always be reinforced longitudinally but some means of providing vertical shear connections will need to be developed to form effective composite beams.

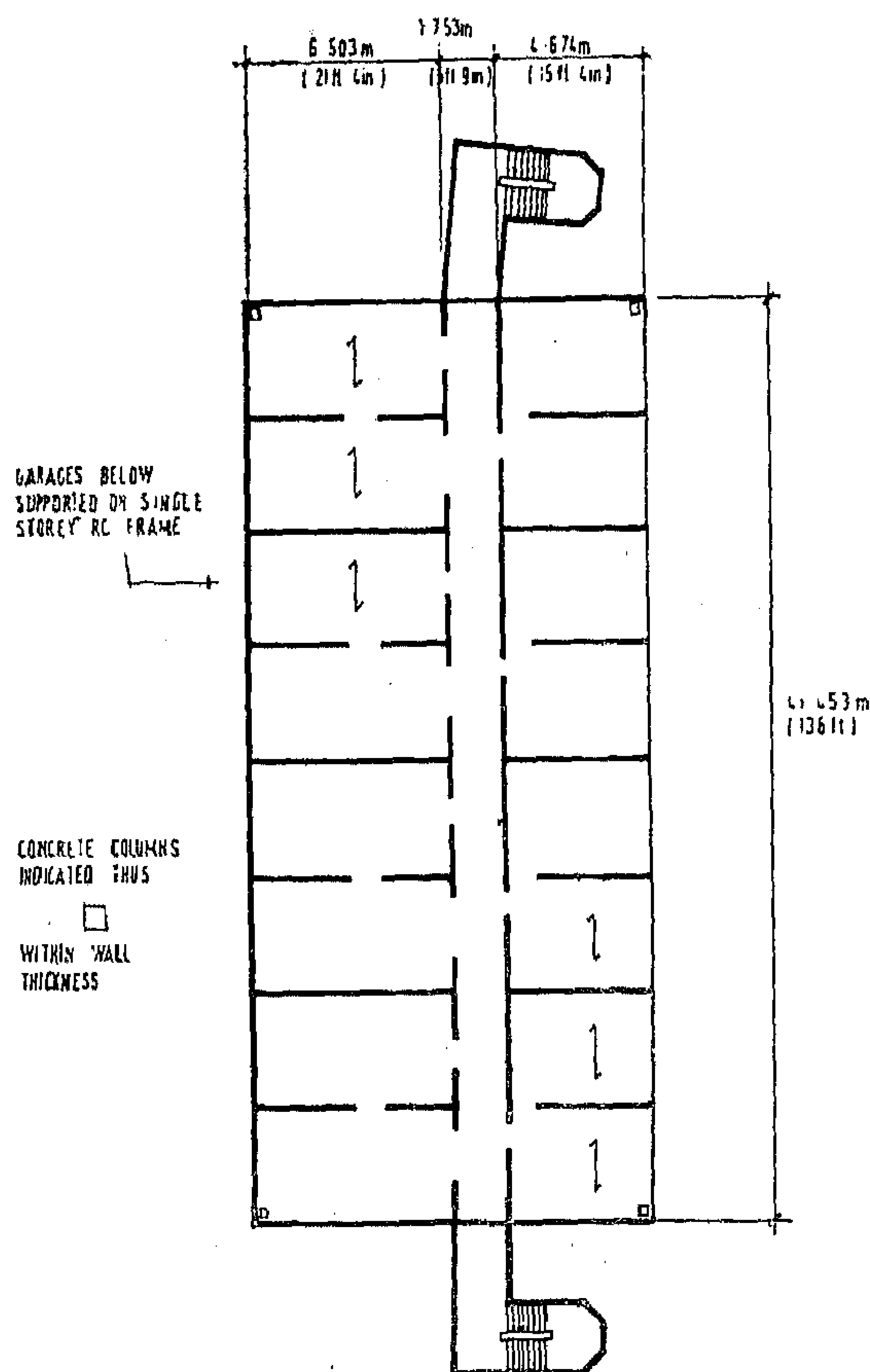


Figure 3 — Part plan of King's Park flats

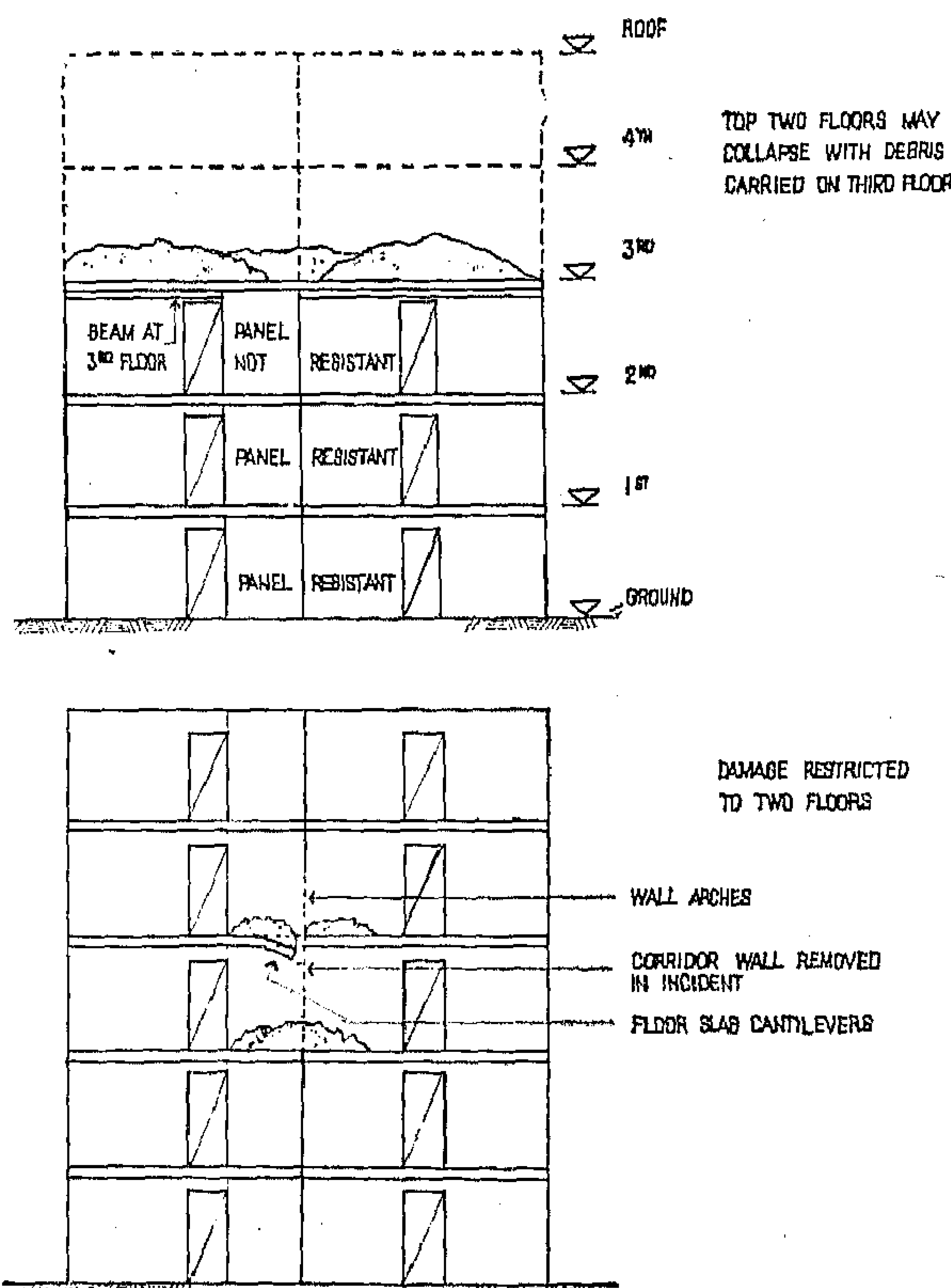


Figure 4 – Some collapse modes considered in the design of King's Park'

used. Information on collapse modes may be found in the paper by Haseltine and Thomas[5]. Figure 4 shows collapse modes considered in the design of Kings Park.

More critical than wall removal can be the disappearance of a floor if it thereby remove wall restraint and doubles the slenderness ratio. On the gable this condition was particularly severe so small concrete posts were incorporated in the corners from ground to third floor level. In common with all elements these were-designed with a load facor of 1.5 under a collapse state. In practice the use of reinforced concrete columns has proved slightly easier than steelwork because of the greater degree of tolerance for matching with the other structural elements. Various types of support are indicated in Figure 5.

4. GENERAL

Residential developments in the medium to high rise range are economic in brickwork only if the total construction effort is less than for other structural forms. This effort consists of analysis, design, drawing and costing, as well as the material costs of walls, floors, cladding, and suitable finishes, plus the labour content of assembling the items and supervising their erection. It is unfortunate that at present too much depends on the attitude of the designer and on the attitude of the Local Authorities who check the designs. Since Ronan Point such checking has quite rightly, become more stringent, but there is danger in over-caution. Risks, to certain levels of probability, have to be accepted.

With the exception of the vertical posts and some downstand beams, the five storey building at King's Park does not differ from one which would have been designed by a competent engineer before the Ronan Point disaster. No changes to brick strength or mortar mix have been necessary. The ability of walls to withstand lateral loading has been well

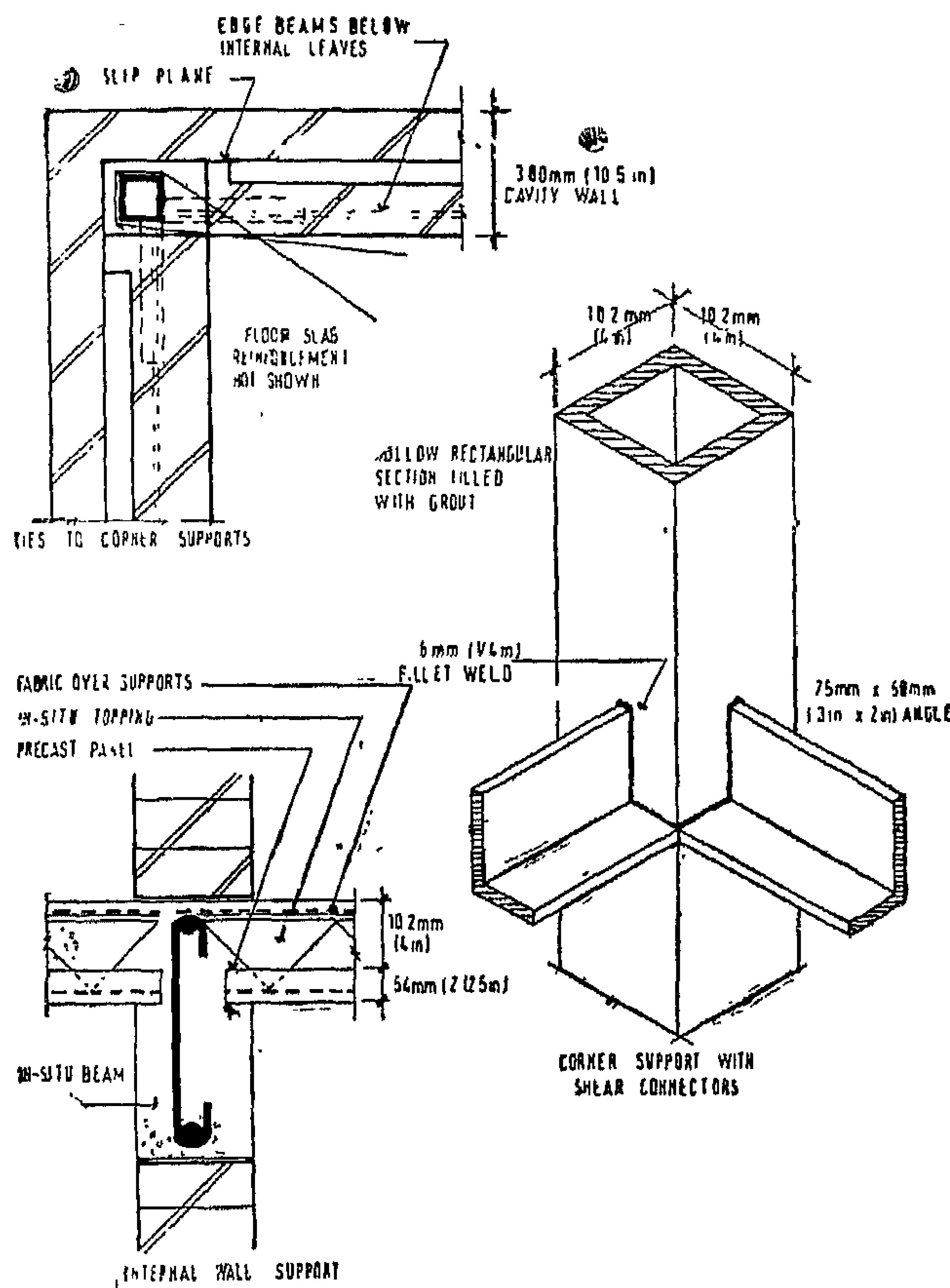


Figure 2. Types of suppert provided against progressive collapse at Croxteth Rd.

nal pressure. Horizontal pull out forces were resisted by reinforcement bent around the sections and bonded to the in situ floor topping.

Construction of the building was slowed down by the necessity to shutter for, and cast, the large number of downstand beams. There were minor problems with obtaining adequate seating for the precast floor panels onto the beams in those cases where they are only 4⅛ in. (105 mm) wide. Two nominal 1¼ in. (32 mm) seatings with space between for the single leg binders between the beams and the topping, leaves little tolerance. All floor panels have secondary reinforcement in the topping to enable them to span in alternative directions in the event of a main support failure.

3. FIVE STOREY BLOCKS DESIGNED IN 1971

A large residential development, King's Park, New Brighton, includes some five storey blocks. Early plans by the Architects, Kingham Knight Associates, had assumed load-bearing brickwork so when detail design started in the spring of 1971 the Fifth Amendment had to be considered On only five storeys, wind forces did not form a design criteria so plate action of the floors was not used to give interconnected shear wall action. Precast prestressed units were therefore chosen for their speed of erection and comparatively low cost due to the large amount of repetition in the project. Methods of obtaining continuity will be discussed later but it is worth noting that because of the small number of storeys and the plan configuration shown in Figure 3, no reduction in brickwork strength would would have been achieved by spanning the floors in two directions and hence reducing loads in the cross walls.

Under the Fifth Amendment, the roof and fourth floor may collapse if the resultant debris can satisfactorily carried on the third floor slab. Between third and second floor the wall panels do not carry sufficient precompression under dead load only to resist accidental damage so beams are used below third floor level. These are compositely designed at WL/50 and have a maximuf span of 21ft 6in. (6.55 m). Bearing of the beams is on gable columns or corridor walls but no internal columns are used. Loadbearing walls from second to first and first to ground are assumed resistant to accidental damage in accordance with the B.D.A. Technical Note[5].

To check a design thoroughly against the removal of elements is a lengthy process and so many cases have to be examined that the normal design effort is at least doubled and may be trebled. Coupled with the additional drawing office methods are

2. EIGHT STORY BLOCK DESIGNED IN 1968

Sketch schemes for a medium rise block in Croxteth Road, Liverpool had been prepared by the Architects, Gearey, Blaira and Weed in early 1968, and engineering advice had given. This resulted in the selection of load-bearing walls in 219 mm ($8\frac{5}{8}$ in.), 178 mm (7 in.) and 105 mm ($4\frac{1}{8}$ in.) thick brickwork, as shown on the plan Figure 1. It had already been decided to use wide concrete shutter panels $2\frac{1}{8}$ in. (54 mm) thick with a 4 in. (102 mm) thick in situ topping. The choice was partly on economic grounds and partly as a structural requisite because such floors can give continuity over joints, a policy of the engineers concerned long before it was compulsory.

Panel soffits of the type used are very smooth and therefore require a minimum of finish before decoration. To provide service corridors and balconies some concrete framing had to be introduced on the elevations between the twin blocks and a vertical movement joint was incorporated in this zone. The structure would therefore have been reasonably resistant to accidental damage with the possible exception of the gables, but of course when the Institution of Structural Engineers issued "Structural stability and the prevention of progressive collapse[4] the building had to be re-assessed.

Eventually a number of vertical props were introduced to take axial loads in the event of partial collapse, and beams were introduced under all load-bearing walls. The rule relating to the maximum wall length of 2.25 x wall height had not at the time been advocated so the props were spaced in accordance with the requirements of the beams above. To obtain minimum interference with the wall layout such props were 4 in. (102 mm) hollow square sections. These were tied to the beams by angle section stubs welded to the props just below floor level. The technique was developed from a system devised for connecting steel columns to flat plate concrete slabs. Figure 2 shows typical tetails.

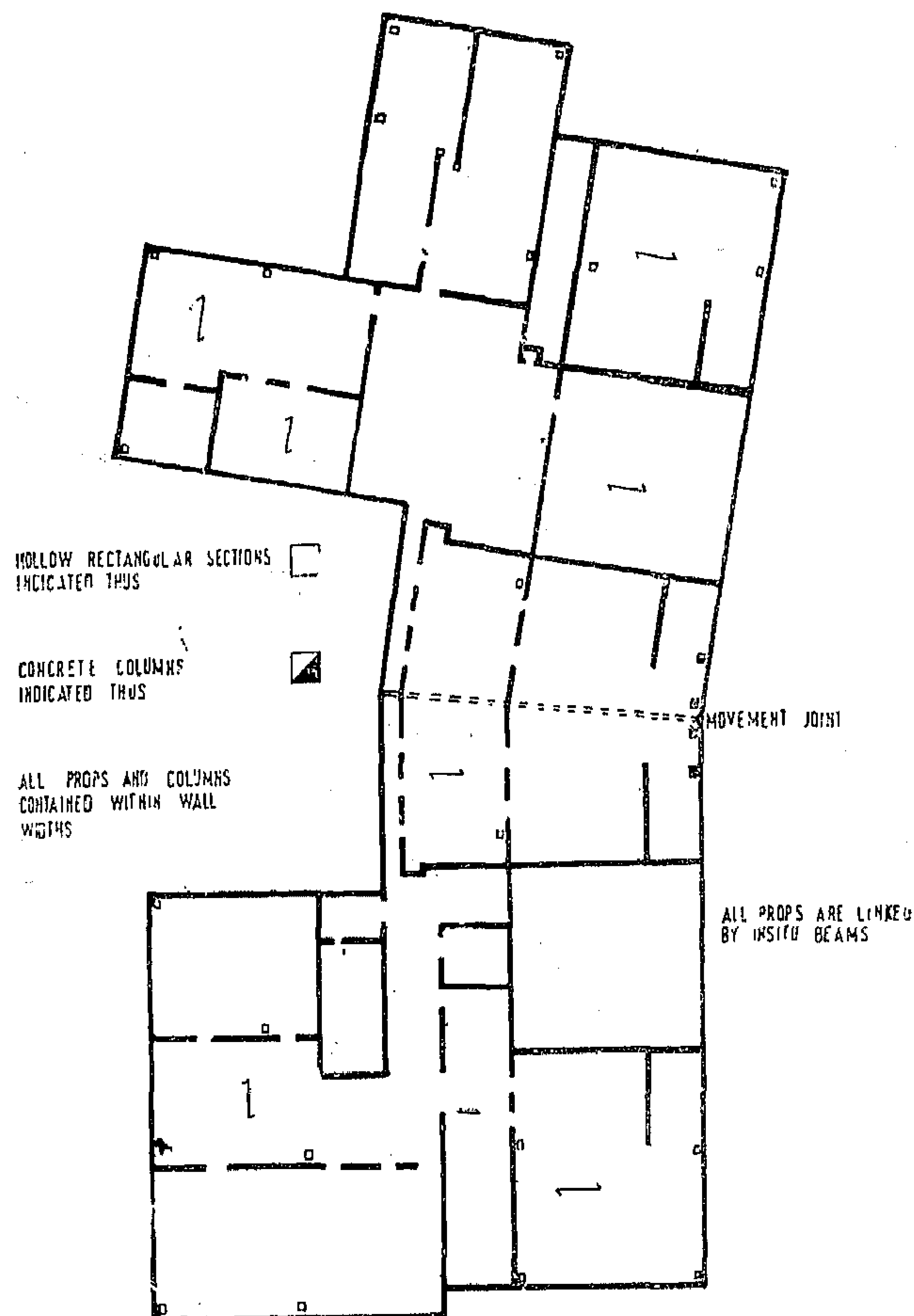


Figure I — Plan of Croxteth Road flats showing structural walls

The columns were not considered to pick up moments from the beams, only axial forces. Increased resistance to buckling and hence increased total load capacity was obtained by filling the hollow sections with grout. This done after each storey of brickwork had been built - the composite props being designed to carry a maximum of six floors. Corner columns were not tied to the walls but slip planes were introduced to avoid lateral load being transmitted in the event of a wall being removed by inte--

DESIGN OF MEDIUM RISE LOAD-BEARING BRICKWORK STRUCTURES TO THE FIFTH AMENDMENT

(ACCORODING TO THE NEW BRITISH STANDARDS)

By : Dr. A. J. M. SOANE

ABSTRACT

Two load-bearing brick structcre are described, one designed in 1968 before the Fifth Amendment was issued, the other designed in 1971 when the Amendment was in force. Common problems were encountered by many engineers involved in this field and numerous solutions were proposed to provide alternative paths of support as opposed to blast-resistant elements, but there was only limited national agreement on interpretation of the recommendations and regulations.

The firsl example is a seven storey block of flats in which vertical supports consisted of grout-filled hollow rectangular steel sections which were linked with in situ ring beams to provide a secondary frame. The later building, of five storeys, used composite beams beneath certain walls but the vertical steelwork supports were eliminated. Even this proposal may be regarded as conservative but the difficulty is emphasised of producing designs which comply with regulations which may be imperfectly understood.

I. INTRODUCTION

The Fifth Amendment to the Building Regulations[1] influences every architect and engineer concerned with buildings of over four storeys in height. Initially, after the Ronan Point report but prior to the Fifth Amendment there was such confusion as to the interpretation of the various interim recommendations that many medium or high rise schemes were abandoned.Subsequently the Amendment was seen to be less restrictive than at first thought, and the chain of events can be illustrated by comparing designs produced in 1968/69 and those being produced in 1971. When this paper is published it may well be thought conservative by virtue of further experimented work or a change in policy at Government level. Indeed other buildings have been built in nearly the same fashion as was possible before 16th May, 1968 and the aim in writing is simple to discuss two typical domestic buildings in the light of opinion available at the time of design.

The changing climate of opinion has been in no small measure due to the valuable work of the British Ceramic Research Association[2] but since the Building Regulations make no mention of explosion, and refer simply to incidents', the wider issues must be considered. A more recent publication by Hendry and Sinha[3], emphasises that such a major incident as the removal of a load-bearing gable has negligible effects on the remainder of the structure. Nevertheless, until local authorities totally accept such evidence, it is necessary to design for the worst.

Bingham Blades and Partners

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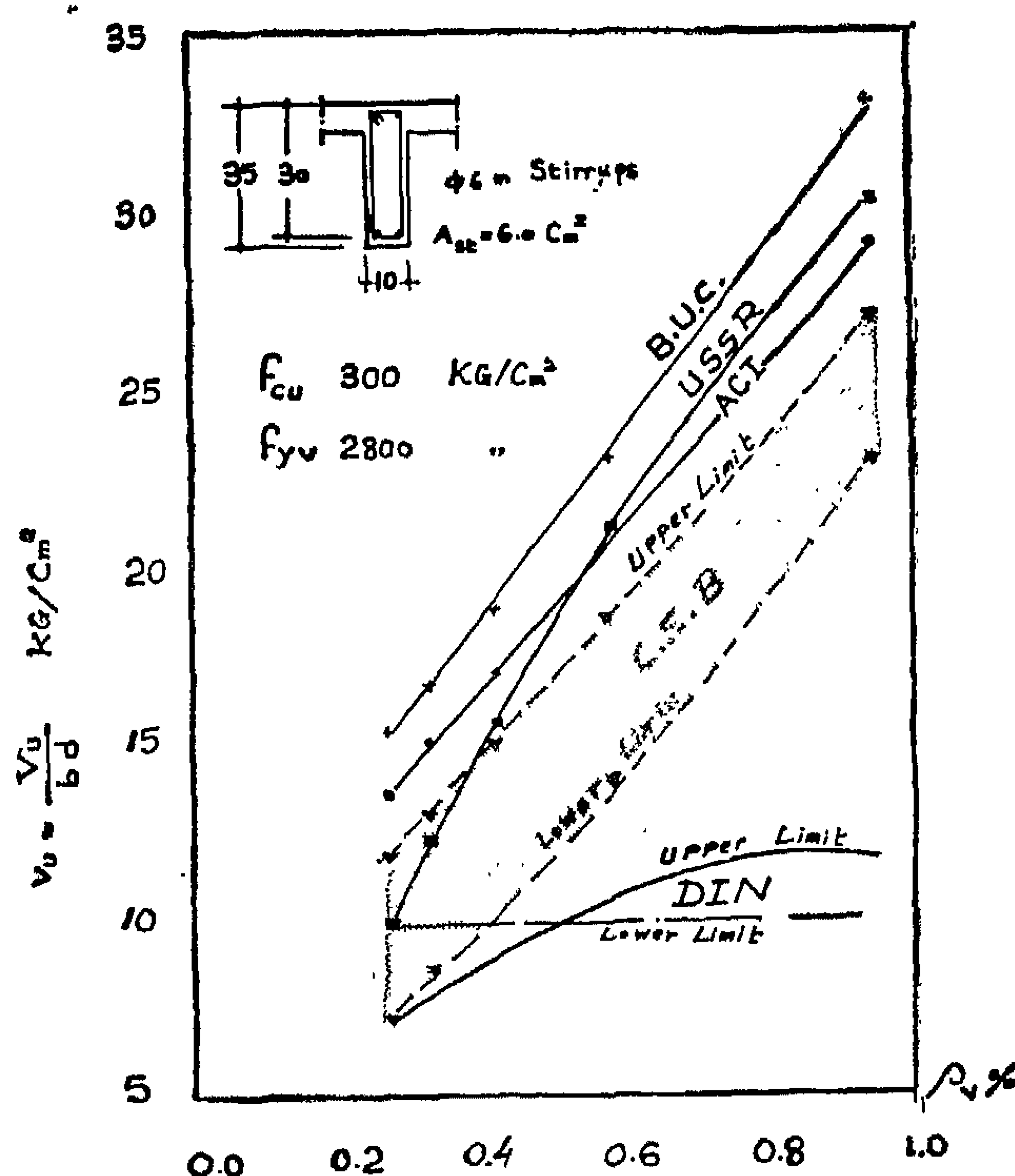


FIG. 4 INFLUENCE OF INTENSITY OF SHEAR RIENFORCEMENT ON STRENGH

2 — The design according to CEB/FIP recommendations might result in a varying distribution of shear reinforcement for constant shear. The design, however, is based on the probable mode of shear failure in each zone; while any beam would be subjected to one mode of failure (7).

3 — The German Code assumes that state I (elastic stage) exists at failure with some imposed values of principal tensile stresses; which contradicts the concept of limit state theory.

4 — The formulae of CEB/FIP, DIN-1045/72 and USSR Codes do not reflect the mechanism of shear failure.

Notations

V	Shear force
V_c	Shear carried by concrete compressive zone
V_u	Ultimate shear force
M_u	Ultimate bending moment
b	Breadth of the beam
t	Total depth of the beam
d	Depth of the beam
a	Distance between concentrated load and the line of action of the support reaction "shear span"
ξt	Lever arm
α	Angle of inclination of web reinforcement to the longitudinal axis of the beam
ϕ	Angle of inclination of the inclined cracks
S	Spacing of the stirrups along the direction of the member
A_v	Cross-sectional area of the web reinforcement per its pitch
	Stress in shear reinforcement
f_{yv}	Yield or 0.2% proof stress of web reinforcement
v_u	Ultimate shear stress (= v / bd)
v_c	Nominal shear stress carried by
f_{cu}	Cube strength of concrete
	Cylinder strength of concrete
f_c^y	
f_{pr}	Prism strength of concrete
f_t	Tensile strength of concrete
f_t	Principal tensile stress.

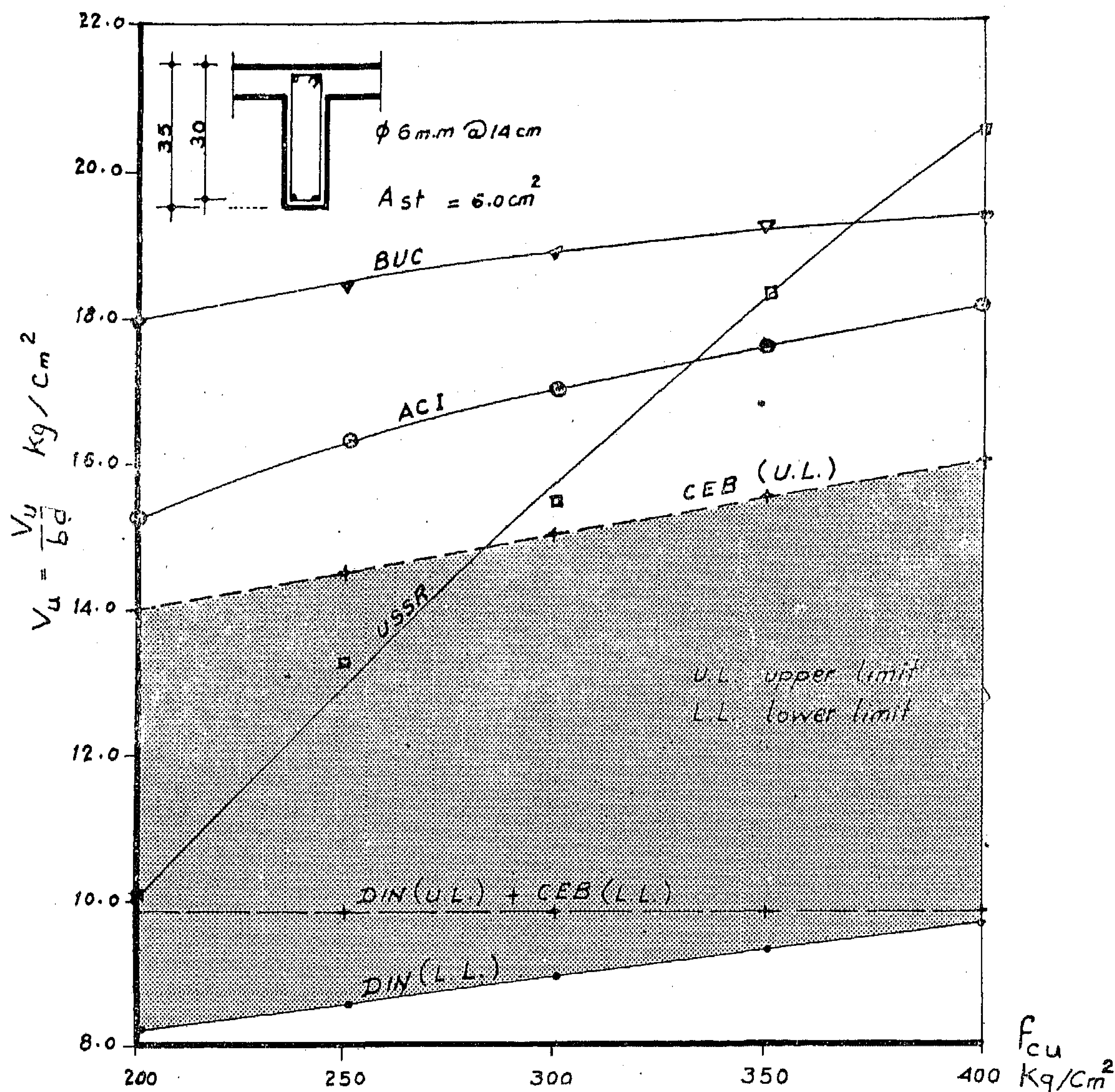


Fig. 3 Influence of concrete strength on shear resistance

8 Comparative study and conclusions :

The different codes of Practice were studied for the ultimate shear capacity as shown in Fig. 3 & 4. Variation in strength of concrete and intensity of shear reinforcement have been tested for the beam indicated on figures. Here British and American Codes showed the highest shear resistance while both CEB/FIP recommendations and DIN — 1045/72 indicated the lowest resistance for both grade of concrete or/and intensity of shear reinforcement. This implies — in design point of view — an overestimation of the required area of shear reinforcement by the latter codes. On the other hand, USSR Code formula for shear resistance showed to be susceptible to variations in concrete strength and intensity of shear reinforeement.

The conclusions revealed from the study can be summarized as follows :

1 — both American and British codes are simple for practical applications than other codes and result in saving of shear reinforcement.

7 - Critical shear (Fig. 2)

Code	Concentrated Load (a, P, c, t)	Uniform Load (c, t, ℄)
RCI 318/72	No provision	(c/2, d)
CEP/FIP (ZONE C only)	$a \leq 2t$; V_{max}, V; V_r (reduced shear) $= V_{max} \cdot \frac{a}{2t}$	(t)
DIN-1045/72	As CEB/FIP $V_r = V_{max} \cdot \frac{a}{2t}$ for $a \leq 2t$	($\frac{t+c}{2}$)
BUC-73	For $P \geq 0.7$ (V_{max}) and $a - \frac{c}{2} \leq 2d$; then V_c increased to $V_c \cdot \frac{2d}{a - c/2} \leq V_{max}$. In such case all main Rft. should continue to the support.	No provision
USSR-62	(l, P, Critical diagonal sec., C) $C = \sqrt{\frac{0.15\, b d^2 f_c}{g_v}}$	Sections (1), (2) and (3) are critical sections.

one or more types of the following :

i — Stirrups perpendicular or inclined (45° or more) to the axis of the member.

ii — welded wire fabric with wires located perpendicular to the axis of the member.

iii — bent bars (30° or more) to the axis of the member. The arrangement of shear reinforcement, in different codes, is summarized in Table (1).

code	ratio $\frac{\text{bent bar}}{\text{total rft.}}$	Max. spacing of stirrups *	Max. spacing of bent bars *
ACI	–	$0.5\,d \leqslant 60$ cm But if $(V_u - V_c) > 1.06\sqrt{f_{cy}}$, then max. spacing of shear rft shall be reduced by one - half	d
BUC	up to 50%	Longitudinal and lateral spacing $\leqslant 0.75\,d$; links should enclose all tension reinforcement.	
USSR	–	$\frac{0.10\, f_c\, b\, d^2}{V_u} \leqslant 0.33\, t$	–
German	–	$0.8\,d$ ($\leqslant 30$ cm) zone 1 $0.5\,t$ ($\leqslant 25$ cm) zone 2 $0.3\,d$ ($\leqslant 20$ cm) zone 3	2 t 2 t t
CEB/FIP	–	▪ 0.85 t for the minimum fixed shear rft. $\simeq 30$ cm $\leqslant 5b$ Zone B $\simeq 15$ cm $\leqslant 3b$ Zone C ▪ ϕ of stirrups or bent bar $\leqslant \frac{b}{8}$	$\simeq 1.5\,t$

* Distance measured along the axis of member

TABLE 1

ii — where the shear stress exceeds a value v (tabulated for different concrete strengths and the ratio), shear reinforcement shall be provided as follows :

$$\frac{A_v}{s} \geqslant \frac{(V_u - V_c).b}{0.87\ f_{yv}} \quad 17$$

where,

$F_{yv} \nless 4250$ kg/cm2

A minimum amount of shear reinforcement should be provided in all members given by :

cm2 / cm 18

$$\frac{A_v}{s} = \frac{4 \cdot b}{0.87\ f_{yv}}$$

cm²/cm ------18

iii — in no case should v exceeds certain limiting value v um for each grade of concrete

5.6 **German Code of practice D I N — 1045 / 72 (4)**

i — German code of practice requires verification of the principal stresses at failure according to the assumption that theory of elasticity still valid. Permissible values of principal tensile stress are assumed in the code as three limits given as :

		v	<	v_1	zone	of	grade	I
v_1	<	v	<	v_2	"	"	"	II
v_2	<	v	<	v_3	"	"	"	III

where,

$$V_3 = \left(\frac{F_{pr}}{4}\right)$$ / appropriate factor of satefy (= 1.75)

$V_2 = 0.6V_3$

$V_1 = 0.25\ V_3$

ii — the calculation of shear stress v is to to be obtained by :

$$V = \frac{V}{b.y_{ct}}\ \frac{M}{tb.y_{ct}}\ \text{an}\ \beta\text{, where} \quad 19$$

β angle between top and bottom edges of the beam.

iii — shear reinforcement calculation is governed by the grade of the shear zone, explained as follows :

(a) ZONT OF GRADE I : no need to calculate for shear reinforcement. A minimum stirrups are to be provided per length of beam as :

$A_v = \frac{b}{4}$ cm2/cm for mild steel

$= \frac{b}{8}$ high tensile steel

(b) ZONE OF GRADE II : in such zone value v obtained from Equation 19, shall be reduced as :

$$v \text{ reduced} = V\left(\frac{V}{V_2}\right)$$

All the resulting reduced shear is to be resisted by web reinforcement calculated using the truss analogy concept (EQ. 3).

(c) ZONE OF GRADE III : in other cases not mentioned in (a) and (b) it is only permitted to exceed v in beams of total depth greater than 45 cm., and only if deformed steel is used or shear reinforcement. In such case, however, the full shear without any reduction is to be resisted by web reingorcement.

iv — The design allowable stress for steel used as web reinforcement is considered equal to fy/1.75 and shall not exceed 2400 kg/cm2.

6 — **Web Reinforcement**

Shear reinforcement proposed by all codes might consist of

i — In regions in which web - shear cracks is about certain (zone B) i.e. $f_i \geq f_c$, the ultimate shear shall be :

$$v_u = 0.67\sigma_i\left(\frac{c}{d}\right) \leq 0.25 \quad (f_{pr\,cu}) \quad ..10$$

Where $\sigma_i = \frac{A_v f_{yv}}{b\,s} + 0.5\sqrt{f_{pr\,cu}}$

Equation 10 applies only for members of horizontal longitudinal axis and having vertical stirrups, but other different cases are also delt with in the recommendations.

ii — In regions where a high probability of cracking under the effect of bending moment in the tension flange i.e. flexural-shear cracking (zone C) the ultimate shear shall be calculated as

$$V = k.\ \frac{A_v}{b.s} \cdot \frac{f_{yv}}{1.15} \cdot \eta \leq 0.2(0.8\ f_{cu}) \quad ...\ 11$$

Where

$$k = (\sin\alpha + \cos\alpha).\ \sin\alpha$$

$$\eta = -\ \frac{3.95\sqrt{f_{pr}\ .\ f_{pr\,cu}}}{v_u}\ \psi\ \xi$$

ξ' = 1.0 for pure-bending and has other formula for combined bending and normal force.

$$\psi = 0.5 + 33\left(\frac{A_s}{bd}\right) \leq 1.0$$

iii — A minimum volume of shear reinforcement should be provided as :

$$\frac{A_v}{S} = \frac{4f_{yv}}{b.\,f_t} \geq \begin{array}{l}0.25\ \%\ \text{for smooth mild steel}\\ 0.14\ \%\ \text{for high quality high bond steel}\end{array}$$

5.4 **USSR Code 1962 (2)**

i — the nominal ultimate shear stress shall be calculated from :

$$V_u = \frac{V_u}{pd}$$

ii — the concrete section shall be considered craked if

$$V_u \geq V_{cr}\ (= F_t)$$

iii — The maximum ultimate shear stress to be carried by a web reinforced section is given nominally by :

$$v_um\ um = 0.25\ f_c$$

where,

f_t and f_c are given in appropriate tables (cube used in USSR is 20 cm side)

iv — shear reinforcement shall be provided if

$V_{cr} \angle V_u \angle V_um$

the ultimate shear $V_u = v_u \cdot b\ d$ is given by :

$$v_u = \sqrt{(0.6\ f_cb\ d^2)\ (q_b + q_v + p)}$$

$+ p_i\ (d = s_i = \sin\alpha) = q_v\ s_v$

where,

S_v and S_i are the spacing of the vertical and inclined stirrups, respectively, along the axis of the member

p intensity of the applied uniform load (might be ignored in some practical cases).

$$q_b = \left(\frac{f_{y1}\ A_1}{s_1}\right).\ \sin\alpha$$

$$q_v = \frac{f_{yv}\ A_v}{s_v}$$

5.5 **British unified Code 1973 (3)**

i — the shear stress shall be calculated from :

$$v_u = \frac{V_u}{b\,d}$$

dowel force, which is generally assumed to be substantial in beams having a high ratio of longitudinal steel with thick concrete cover. It is evident that this action decreases appreciably by the use of web reinforcement and vanishes at ultimate shear conditions (11).

iv — **Aggregate interlock**

The frictional forces between the surfaces of either sides of the inclined cracks are refered to as aggregate interlock. Investigators found it difficult to simulate the conditions at inclined crack (12). Openions on both dowel action and aggregate interlock differ considerably and in most cases the magnitude of these actions have been greately overestimated.

5 — Shear clause in current codes of practice

5.1 UAR specifications 1969 (13)

i — The shear clause applies for slabs, beams and girders.

ii — If the maximum shear stress obtained from formula $v = \frac{V}{b.y_{ct}}$ does not exceed a certain specified value v_1 for different concrete strengths, no specially designed web reinforcement need to be provided.

iii — The shear stresses lie between the value v_1 and v_2, the whole diagonal tension resulting from these stresses should be resisted by web reinforcement.

iv — The amount of shear reinforcement, as vertical stirrups, is obtained by :

$$\frac{A_v F_v}{S.b} = \frac{V}{Y_{ct}.\, b} \qquad 3$$

5.2 A C I 318 — 71 (1)

i — The nominal ultimate shear stress shall be computed as :

$$V_u = \left(\frac{V_u}{b.d}\right) / \phi \qquad 4$$

where

ϕ capacity reduction factor equal to 0.85 for shear, used to obtain reasonably dependable strength.

ii — Shear resisted by concrete v_c is given by

$$v_c = 0.53 \sqrt{f_{cy}} \quad kg/cm^2 \qquad 5$$

and for more detailed analysis v is obtained as

$$v_c = 0.504 \sqrt{f_{cy}} + 176\left(\frac{As}{bd}\right).\left(\frac{v_u d}{M_u}\right) \qquad 6$$

v_c shall not exceed $0.928 \sqrt{f_{cy}}$. 7

where,

f_{cy} = cylinder strength of concrete (15 x 30 cm) and

iii — Shear reinforcement shall be provided when the nominal ultimate shear v_u exceeds the value v_c obtained in (ii), as follows :

$$\frac{A_v}{S} = \frac{(V_u - V_c)\, b}{f_{yv}\,(\sin + \cos)} \qquad 8$$

Where,

$(v_u - V_c) \leq 2.12 \sqrt{f_{cy}}$ kg/cm²

and $f_{yv} \leq 4\,200$ kg/cm²

A minifum amount of web reinforcement shall be provided in structural members as :

$$\frac{A_v}{S} = \frac{3.52\, b}{F_{yv}} \qquad 9$$

5.3 C E B/ F I P — 1970 Recommendations (14)

The following expressions for the strength in shear are obtained from the 1970 International Recomfendations of the Europian Committee, which have been put in a form comparable to other codes.

of allowable shear stress and whenever the shear stress obtained from this formula exceeds a safe value ; web reinforcement should be provided. The amount of this reinforcement is calculated according to the traditional Mörsh truse analogy and the following formula was derived :

$$\frac{v}{b.y_{ct}} = \sin^2 \alpha \ (\cot \alpha + \cot\phi) \ \frac{A_v f_v}{bs} \quad 2a$$

Mörch assumed = 45°, hence if vertical reinforcement is to be used, formula 2 will be :

$$\frac{A_v f_v}{bs} = \frac{V}{by_{ct}} \quad 2b$$

4 — Ultimate shear

4.1 Criterion of failure

The prevailing thought about shear failure is based on a critical combination of normal and shear stresses in the concrete compressive zone (6). In his thesis (7) the writer has discussed this problem in detail and proposed criteria based on a critical shear stress alone. However the citeria of shear failure is still vague and obviously dependant on mode of failure.

4.2 Modes of failure

The common modes of shear failure could be classified as :

1 — Shearing or crushing of the com pression flange (diagonal tension and shear compression, respectively).

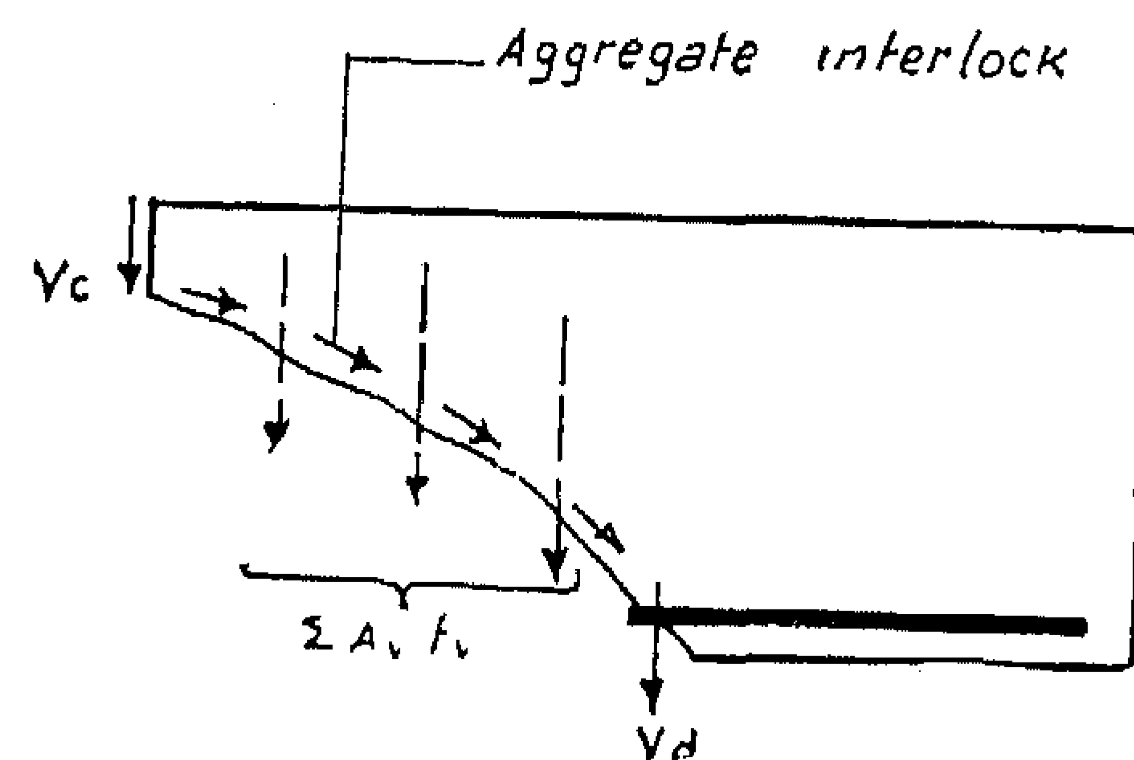
2 — Crushing of the concrete web in thin - webbed sections (inclined compression).

3 — Instability of the top flange (considered as a secondary mode in the previous research work).

4.3 Components contributing to the ultimate shear strength (Fig. 1)

Concrete compression zone

The test result have showed that an appreciable amount of shear is carried by conrrete (8). Talbot (9) proposed this amount to be about 1/3 to 1/4 of total shear. Such contribution however cannot be expressed by a fixed ratio. Present codes of practice recognise the contribution of concrete in ultimate shear. Both American and British codes (1,3) assume the shear resistance of concrete to be equal to the shear causing the formation of the diagonal tension crackes.



Σ Av fv contribution of stirrups
Vd .... dowel action
Vc .... contribution of concrete

Fig. 1 Components of ultimate shear strength

ii — Concrete web and web reinforcement

The Mörsh truss analogy has been used in west European codes by which the web reinforcement was assumed to carry total shear. The writer showed that the shear resistance of the web reinforcement has a limited value (7) and hence the increase of web reinforcement does not increase the shear strength beyond this limit. Work on the inclined compression mode of failure has showed that the actions of web reinforcement and concrete web are complementary (10).

iii — Dowell action of longitudinal reincement

The transverse component of the tensile force resisted by the longitudinal reinforcement is termed by

CRITICAL AEVIEW OF THE SHEAR CLAUSE OF R.C. BEAMS IN PRESENT CODES OF PRACTICE

S. Y. DEBAIKY

1 — Introduction :

The conventional method of design of reinforced concrete members for shear is based on the elastic theory which ignores completely the mechanism at failure. This method of design does not consider the contribution of concrete in shear resistance and hence overstimates the amount of reinforcement. Present codes of practice (1, 2, 3, 4,) have introduced the concept of ultimate shrength in shear design.

The introduction of the concepts of limite state design in the unified code of practice for the Arab Countries araised a great deal of discussion about the riddle of shear problem (5). Here the writer intends to compare the conventional thought with that of the new concepts of shear analysis. Shear clause in the present Egyptian and other codes of practice will briefly be summarized.

2 — Response of beam loaded to shear failure

Three clear stages can be distinguished in the history of a concrete beam failing in shear.

i — The uncracked stage in which the beam is considered to behave as an elastic structure in which the load-strain relationship is linear.

ii — The cracked stage which is characterised by the presence of inclined cracks. As the inclined cracks propagate, the original beam action is gradually replaced by a highly indeterminate internal structrre.

iii — The ultimate failure stage which is affected by the inclined cracking pattern, the cross-section properties and other different components of beam structure.

3 — Conventional concept

According to the theory of elasticity, a shearing force V at right angle to the axis of the beam produces shearing stresses at right angle ant parellel to the aris. The combination of normal and shear stresses result in a principal tensile stress acting at inclined angle to the axis of the member.

In a cracked reinforced concrete member, the concrete is assumed to carry no tensile stress. The distribution of shear stress on the cross-section therefore, is maximum at the neutral axis ant constant The following formula can be obtained : in the cracked part.

$$v = \frac{V}{b \cdot y_{ct}}$$

The value of shear stress obtained from this formula is considered as a measure of the ability of r.c. member to resist shear. The different codes give a specified value

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of high sediment concentrations near the bed for near uniform bed material.

It is found that by changing the von karman coefficient equally in both the velocity and the suspended sediment distributions, a reasonable solution is obtained for both flume experiments and river measurements. The changed K-value is predicted as a function of the dimensionless parameter $(V_{s32} \cdot D_{62})/(q^{1/2} \cdot s_e^{1/2} \cdot x^{1/2})$

ACKNOWLEDGEMENT :

The research forming the basis for this paper was presented as a thesis (1) by the writer to the University of California, Berfeley in December 1969 in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

The author wishes to express his sincere gratitude to Prof. H.A. Einstein for his guidance and valuable advice throughout that study.

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variables was changed individually keeping the others as constants and then by the trial-and-error procedure the value of K was found. Fig. (1) shows that a change of 100 % in the rate of sediment transport q_s, results in a change of 12 % in K-value for the Niobrara and the Middle Loup Rivers. The von karman coefficient K was found to be a function of the dimensionless parameter $(V_{s35} \cdot D_{65}) / (q^{1/2} \cdot S_e^{1/2} \nu^{1/2})$ as shown in Fig. (2). It is proposed that this curve may be used for the prediction of K-values.

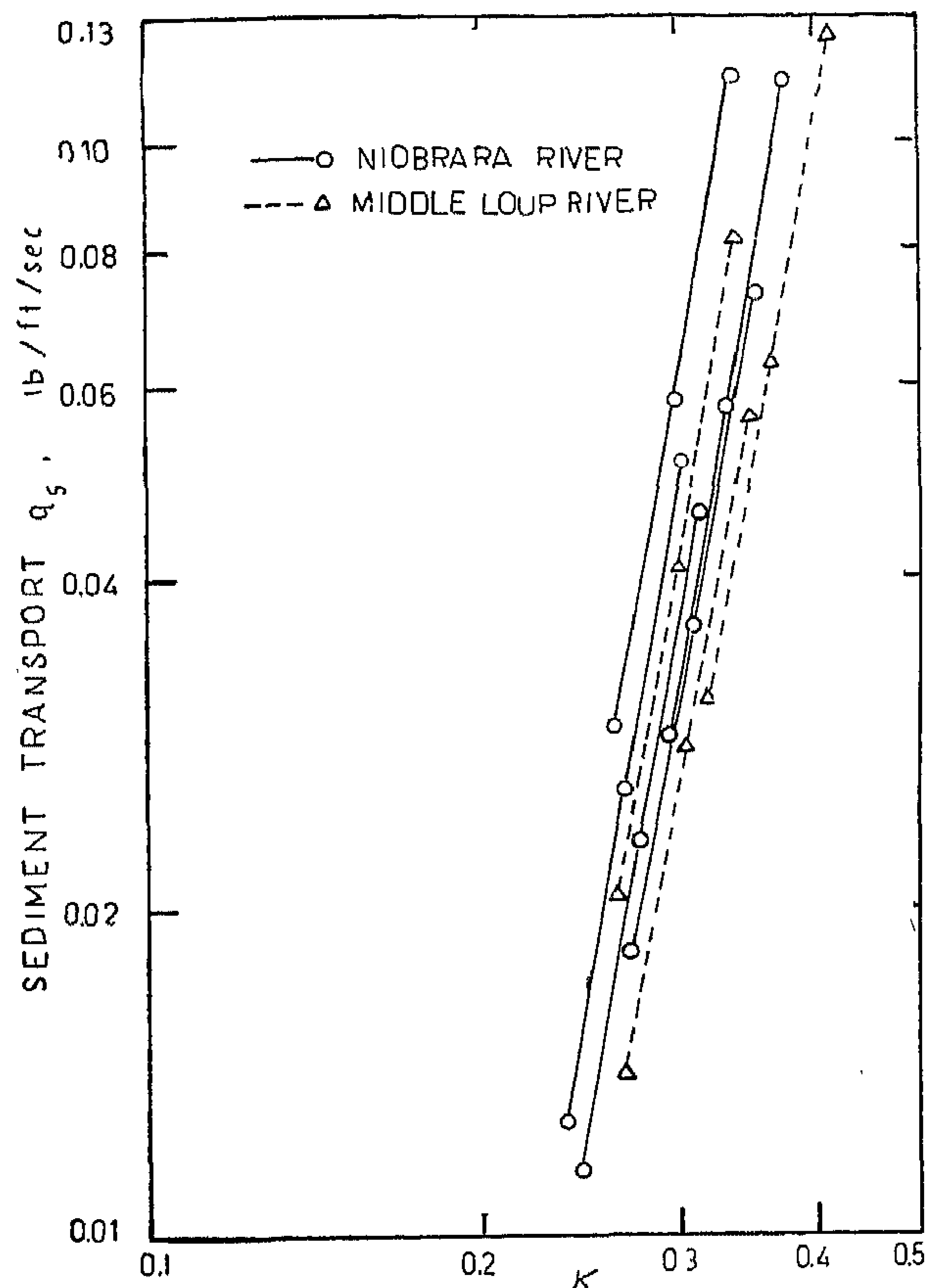


FIG 1 VON KARMAN COEFFICIENT K VS SEDIMENT TRANSPORT q_s FOR THE NIOBRARA AND MIDDLE LOUP RIVERS

The scater of the points on Fig. (2) may have two reasons. The first is the fact that for the flume experiments all the flumes were assumed to have the same side wall friction which might not be the case in reality. The second is the fact the river points represent individual measurements at different locations on dicerent days and under different conditions of temperature and wash load.

It is well known that both the viscosity of the flow ν and the settling velocity Vs 35 of the particles are significantly altered at high sediment concentrations. If the results of the study look reasonable, one must assume that the change of these two important parameters is implicitly introduced by the change of K value.

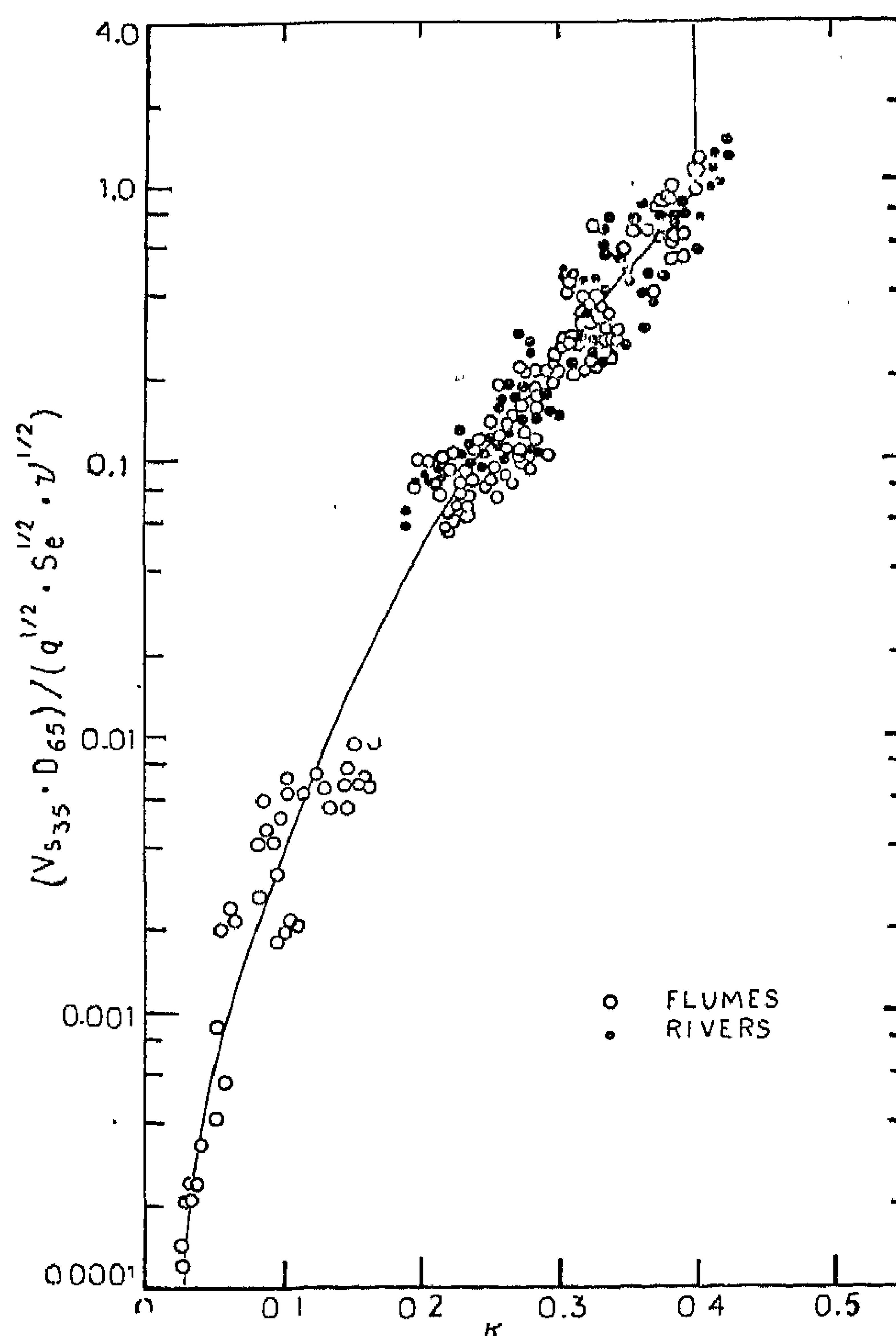


FIG 2 VON KARMAN COEFFICIENT K VS $\left(\frac{V_{s35} \cdot D_{65}}{q^{1/2} \cdot S_e^{1/2} \cdot \nu^{1/2}}\right)$

SUMMARY AND CONCLUSIONS :

In this paper a method is suggested which can be used to extend the applicability of bed-load calculations to the case

$$\frac{U}{U_{*I}} = \frac{2.3}{K} \lg_{10} (12.27 \; R_{bI} \frac{X}{K_s}) \qquad (1)$$

where U is the average flow velocity, U_{*I} is the shear velocity with respect to the grain, K the von Karman coefficient, R_{bI} is the hydraulic radius with respect to grains on the sand bed, X is a parameter for transition smooth-rough, and K_s is the roughness diameter.

Normally bed-material load calcula-and the geometry then deriving from that composition of the bed, the discharge, and the geometry than deriving from that the flow condition (depth and velocity) and the sediment transport, using a set of variable equations. Here the sediment load was measured and the K-value which enters both the hydraulic and the sediment calculations is determined. One may consider, however, that this determined value of K is somewhat fictitious and may not accurately describe either the velocity or the sediment distributions, but it gives in the same time a better description of the total sediment load. It is impossible to solve the rather complicated set of equations for K and to calculate this value direttly. So the value of K was found by the trial-and-error method. With the help of the electronic computer this method was quite feasible.

For the above-described trial-and-error calculations, a computer program was prepared using the CDC 6400 in FORTRAN IV (1). Flume experiments by different investigators (8, 9, 10, 17) were calculated by the this procedure.

To check the method for natural channels, another computer program was prepared (1). Nine river reaches in the united States were chosen (13, 14, 15), for which sediment measurements are available. They are:

1. Mississippi River, St. Louis, Missouri.
2. Mississippi River, Tarbert Landing, Mississippi.
3. Atchafalaya River, Simmesport, Louisiana.
4. Red River, Alexandria, Louisiana.
5. Rio Grande River, Bernallilo, New Mexico.
6. Niobrara River, Cody, Nebraska.
7. Middle Loup River, Dunning, Nebraska.
8. Colorado River, Taylor's Ferry, Arizona.
9. Missouri River, Omaha, Nebraska.

RESULTS AND DISCUSSION :

In fine sand transport, where almost all the sediment load moves in suspension, some energy is consumed in supporting the particles in suspension. This energy is taken from the energy of turbulence, causing the von Karman K to be reduced (6).

While the friction equation was introduced in the form of Eq. (1), it is necessary to introduce the variable K-value also in the velocity distribution. This was done in the form of Eq. (2).

$$\frac{U}{U_{*I}} = (\frac{2.30}{K}) \log_{10} (30.2 \frac{yx}{K_s}) \qquad (2)$$

where y is the distance above the bed and the other symbols are as defined in Eq. (1).

This function was used to integrate the suspended load over the vertical leading to the expression P_I, the ratio of the total transport per unit width of a given grain size to the corresponding transport in the bed layer, which replaces the value of P in the bed-load function (2),

$$P_I = (0.4/K) \log_e (30.2 \; x.d/K_s).I + (0.4/K) I_2 \qquad (3)$$

where d is the water depth and I_1 and I_2 are integral values.

An attempt was made to find a parameter which can describe K accurately. All the variables that might affect the K-value were studied. Each one of the

SEDIMENT TRANSPORT IN FINE SANDS

By

Dr. FAROUK M. ABDEL-AAL*

INTRODUCTION :

In alluvial channels consisting of fine sands, almost all the sediment load moves in suspension with high concentrations near the bed. These high concentrations affect many of the flow characteristics the roughness is changed, the velocity profiles are altered, the density and viscosity of the fluid are increased, and the particle fall velocity and the von Karman coefficient K are reduced.

This paper describes how the Einstein Bed-Load Function (2), can be modified in order to better describe flows with high sediment rates of fine grain. Instead of constant K-value of 0.4, both the distributions of velocity and suspended sediment use a variable K-value which was found to be a function of a certain parameter, but becomes 0.4 when the parameter is larger than 1.

In the early fifties measurements in the Missouri River showed that the Von Karman coefficient K is not a constant value. A special set of flume expeniments (6) was conducted to find the reason for the deviation and it was found that the Karman coefficient K was systematically reduced from 0.4 whenever the concentration near the bed became larger than 10 % by weight. With the coefficient K changed, the entire velocity distribution and the friction law changed, as well as the distribution of the suspended load in the vertical.

Much study has gone into this change of the Karman coefficient since then, and researchers in various laboratories have tried to find a solution to this riddle. First, it was observed that the change of K appears to be different in its application to the friction law and to that of the suspended load distribution (4, 11). However, this difference could be only apparent, as it may be caused by other factors. For instance a changed settling velocity of the suspeneded particles or some other effect could influence the two equations in different ways. But one effect appears to be obvious from all measurements: There exists an average K-value for both the velocity and the suspended load distributions which discribes them from the water surface down to a point close to the bed (6).

THE PROPOSED THEORY :

The question was now asked if it is possible to obtain an acceptable approximation for the description of all the many river and flume experiments which have become available, if K is permitted to assume values different from 0.4. A method must be derived for predicting this value in each case. Furthermore, an equation must be derived for the friction law containing a variable K-value which in the limit of low sediment concentration reverts to the form used in the

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The high values of KD and S' in the P_4 is probably due to leakage through the overlying confining layers in the area of P_4, this means that the clay layers between 22 and 25 m is not completely impervious, i.e. semi-pervious.

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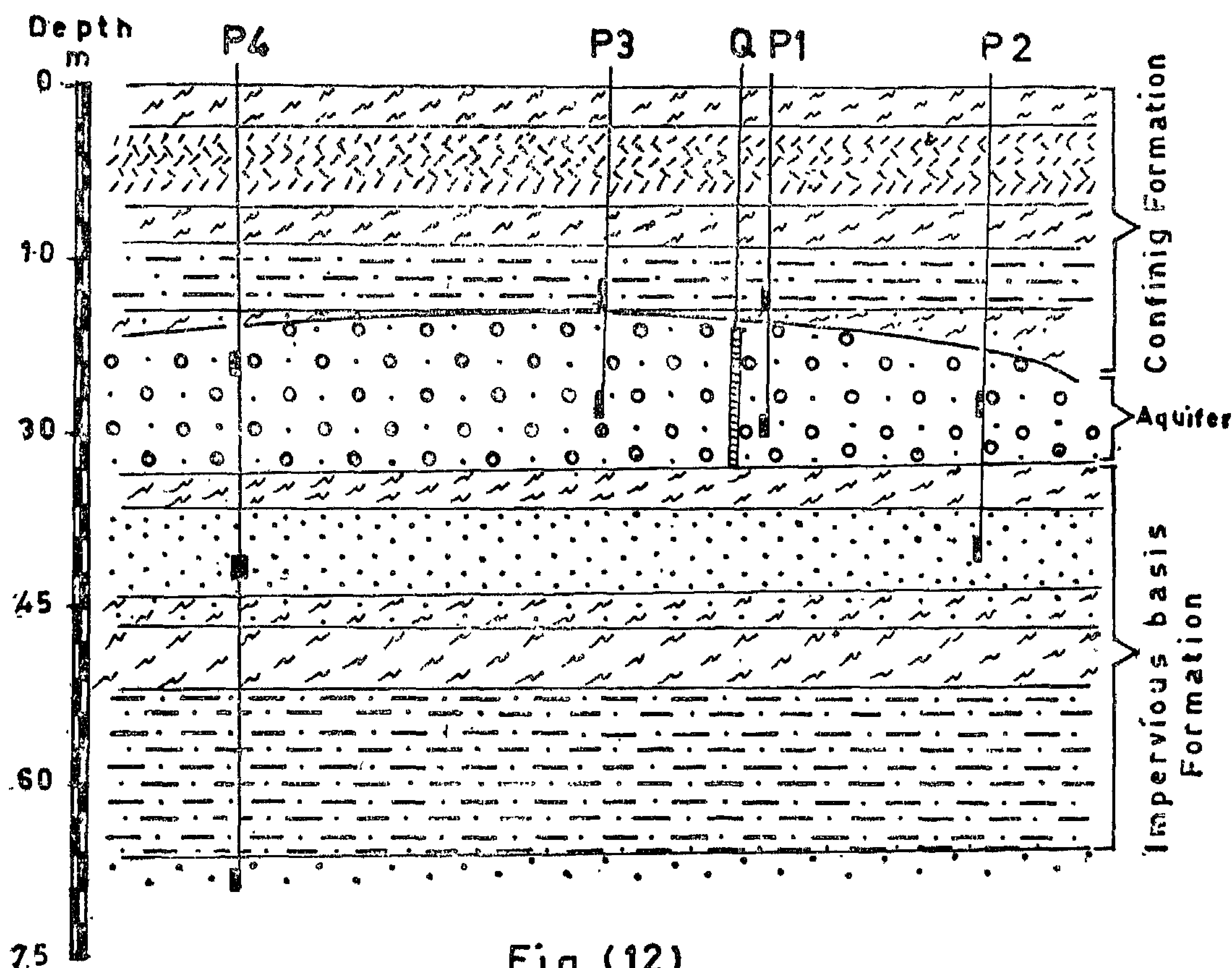
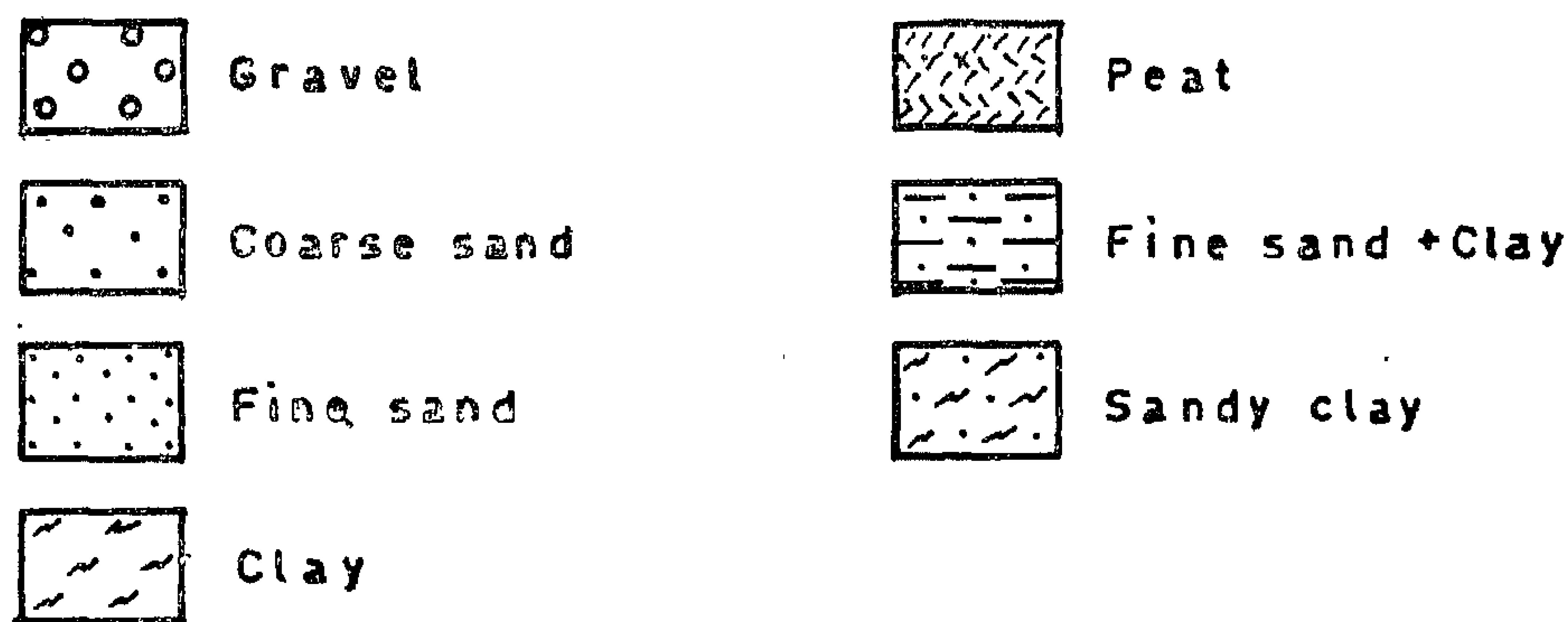


Fig. (12)

Lithological cross-section of the pumping test site south Rotterdam



The analyzis of the well logs in this area shows that the transmissivity KD in the vicinity of (P_4) is probably somewhat higher than that in the vicinity of the other piezometers. This has been proved by analyzing the pumping test data and the values of the aquifer characteristics, which can be seen in table (1).

The transmissivity value in the vicinity of P_4 equal to 1004, while the average transmissivity in the vicinity of the other Piezometers falls between 350 — 400 m²/day. The same thing, with respect to the storage coefficient S′ in the vicinity of P_4 which equal to $6x10^{-4}$, while the average value of S′ in the vicinity of other piezometers ranges from 1.5×10^{-4}.

ved data, the thickness of the aquifer is then greater than that obtained from Eq. (21).

Hantush's modification of Theis method for unsteady pumping test analysis is useful tool when the average thickness of the artesian aquifer at the test site is not known in advance, and can be used if the following assumption and conditions are satisfied.

— Assumptions from 1- to 4 listed earlier under general assumptions.
— The pumped well partially penetrating the aquifer.
— The flow to the well is in unsteady state.
— The time of pumping is relatively short $t < \{ (2D - l - x)^2 (S'/D) \} / 20k$

where $x = \frac{l' + d'}{2}$

Results and evaluation :

The author used the data from the pumping test performed in "Schidam-Rotterdam" in Holland as a numerical example to illustrate and compare some of the above described methods of analyzing steady and unsteady flow to a pumped well in a confined aquifer.

Fig. (12) shows a lithological cross-section of the area as derived from the drilling data. This section shows that the first 27 m below the surface, consisting of clays, peat and clayey fine sand which forms the impervious confining layer. Between 27 and 35 m below the surface the aquifer consists of rather coarse sand with some gravel. The base of the aquifer is formed by fine sandy and clayey sediments, which can be considered as impervious beds.

The screen of the pumped well was installed over the whole thickness of the water-bearing horizon and four piezometers P_1, P_2, P_3, P_4, were placed at different distances from the pumped well i.e. 3, 25, 100, 300 m and at different depths.

The filters of the piezometers P_2 and P_4 were placed at a depth of 45 m showed a drawdown during pumping. The well was pumped with a constant discharge = 1200 m^3/day. Asummary of the calculated values of the aquifer characteristics is given in table (1).

It may be concluded that the confined aquifer has the following average aquifer characteristics :

KD = 450 m^2/day

$S' = 1.5 \times 10^{-4} — 2.5 \times 10^{-4}$

Table (1)

Results of the application of differentmethods of analyzing pumping test data from "Schidam Rotterdam" in Holland.

Method	Data from Piezometers	KD m^2 / day (approximate)	Storage Coefficient (S') (approximate)
Thiem I	P_1, P_2, P_3, P_4	380	1.5×10^{-4}
Thiem II	P_1, P_2, P_3, P_4	340	2×10^{-4}
Theis	P_1, P_2, P_3, P_4	400	2.3×10^{-4}
Jacob I	P_2	400	1.7×10^{-4}
Thiem II	P_3	458	2.9×10^{-4}
Jacob I	P_4	1004	6.5×10^{-4}
Jacob II	P_1, P_2, P_3, P_4	480	2.5×10^{-4}
Jacob III	P_1, P_2, P_3, P_4	450	1.8×10^{-4}
Chow	P_2	380	2.2×10^{-4}

All the above methods assume that the pumped well fully penetrating an artesian aquifer. In cases where an unconfined aquifer is encountred and / or the condition of full penetration can not be practically accomplished in the field, modifications to or extensions of the above formulae are necessary.

E. **Hantush (1962)**: Presented a non-steady state solution to the problem of partial penetration of an artesian aquifer He used the function E (U) = M (U,B), in which U is the standard parameter used by Theis in the development of the problem for fully penetrating wells, and B is a parameter dependent upon the depth of penetration of the pumped well and the distance to the observation well. Solution for the KD and S′ through use of this method involved plotting a type-curve of E (U) versus 1/U (log-log) and a data curve of S versus t (log-log).

Superimpose the observed data curve on the type curve and adjust, while keeping the coordinate axes of the two curves parallel, until as many as possible of the observed data points fall on the type curve; It will be seen that for relatively large values of time the observed data curve deviates upward from the type curve. This deviation is to be expected because the type curve is based on the assumption that pumping time is relatively short. After superimposing the two curves a match point A on the superimposed sheets is selected in the range where the curves do not deviate and note for A the coordinates values of E (U), 1/U , t and then substitute these values into the following Eq.

$$K = \frac{Q}{8\pi(l-d)} \; \frac{E(u)}{S} \qquad (19)$$

from which K can be computed.

Then substitute the value of 1/U and t into the following Eq.

$$u = \frac{r^2 \, S'/D}{4kt} \qquad (20)$$

from which S′/D can be computed which is known as specific storage coefficient, i.e. the volume of water released from storage in a unit volume of the aquifer under unit-head decline and (expressed in m^{-1}).

The data curve departs from the type curve, the departure point 1/Ud is recorded and note the value of 1/U corresponding this point, and then compute the value of D from the relation

$$D = 0.25\left(2l + l' + d' + 4.48\, r \sqrt{\frac{1}{u_d}}\right) \qquad (21)$$

in which l and l' are the depths of penetration of the pumped and observation wells respectively, d, d' is the depth of penetration of the pumped and observation wells casing into the aquifer, r is the distance from the observation well to the pumped well and D is the thickness or the pumped aquifer see Fig. (11)

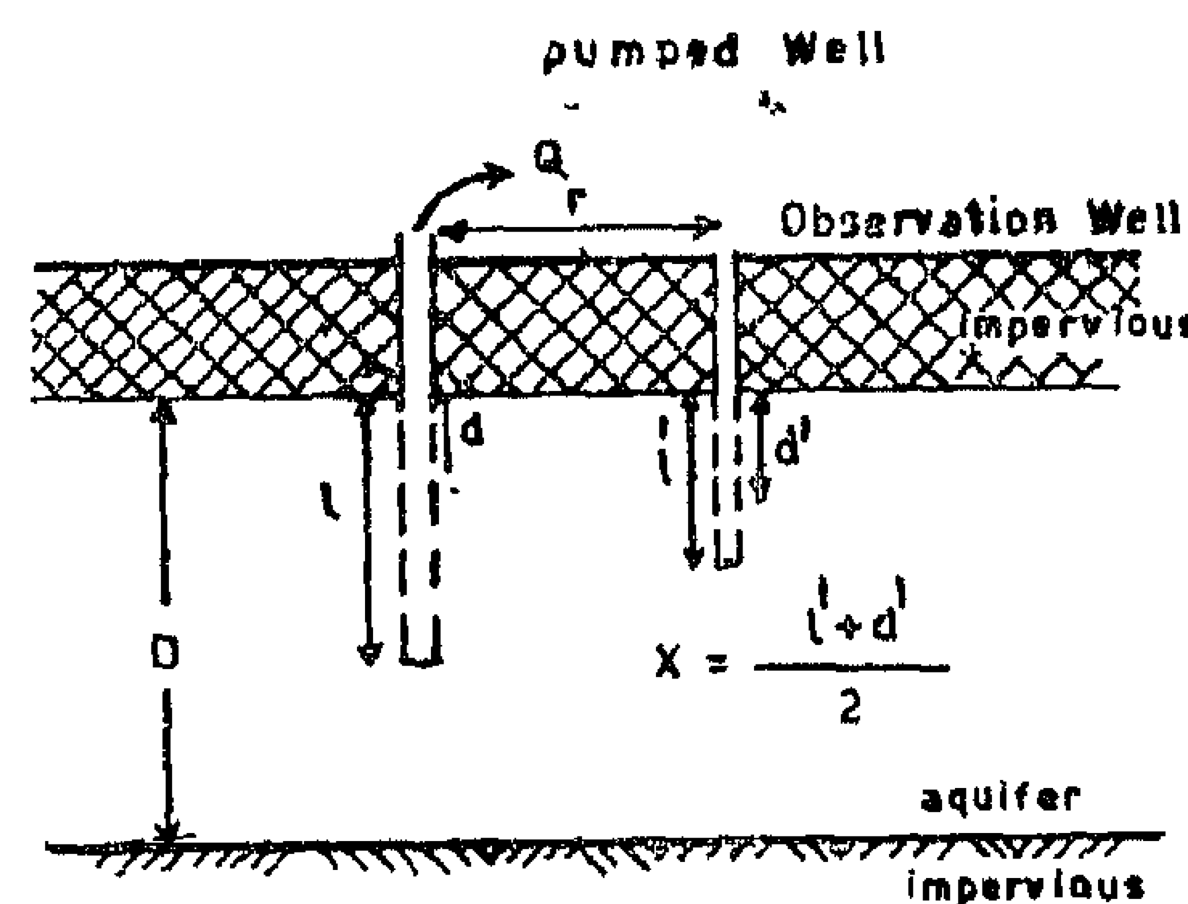


Fig (11)

Schematic illustration of the parameter of Hantush modification of Theis's method for partial penetration

Once the average thickness of the aquifer and the permeability coefficient are known, then the value of transmissivity can now be calculated.

If the data curve dose not depart from the type curve within the range of obser-

S'_R = storage coefficient during recovery dimensionless.

S' = storage coefficient during pumping dimensionless.

t = time in days since pumping started.

t_R = time in days since pumping stopped.

Q = recharge rate or discharge rate in m^3/day.

S' and S'_R almostly and in all cases are equal and constant and $U = r^2S'/4KDt$ is sufficiently small, in this case Eq. (16) can be written as

$$S_R = \frac{2.30}{4\pi kD} \log \frac{t}{t_R} \qquad (17)$$

Procedure:

For one of the piezometers or for the pumped well S_R is plotted versus t/t_R on a single logarithmic paper (t/t_R on logarithmic scale) and a straight line is fitted through the plotted points, Fig. (10). The slope of the line is equal $2.30\,Q/4\pi KD$; hence the value of $\triangle S_R$ the residual drawdown difference per log cycle of t/t_R can be read from the graph and substituted into Eq. (18).

$$KD = \frac{2.30\,Q}{4\pi \Delta S_R} \qquad (18)$$

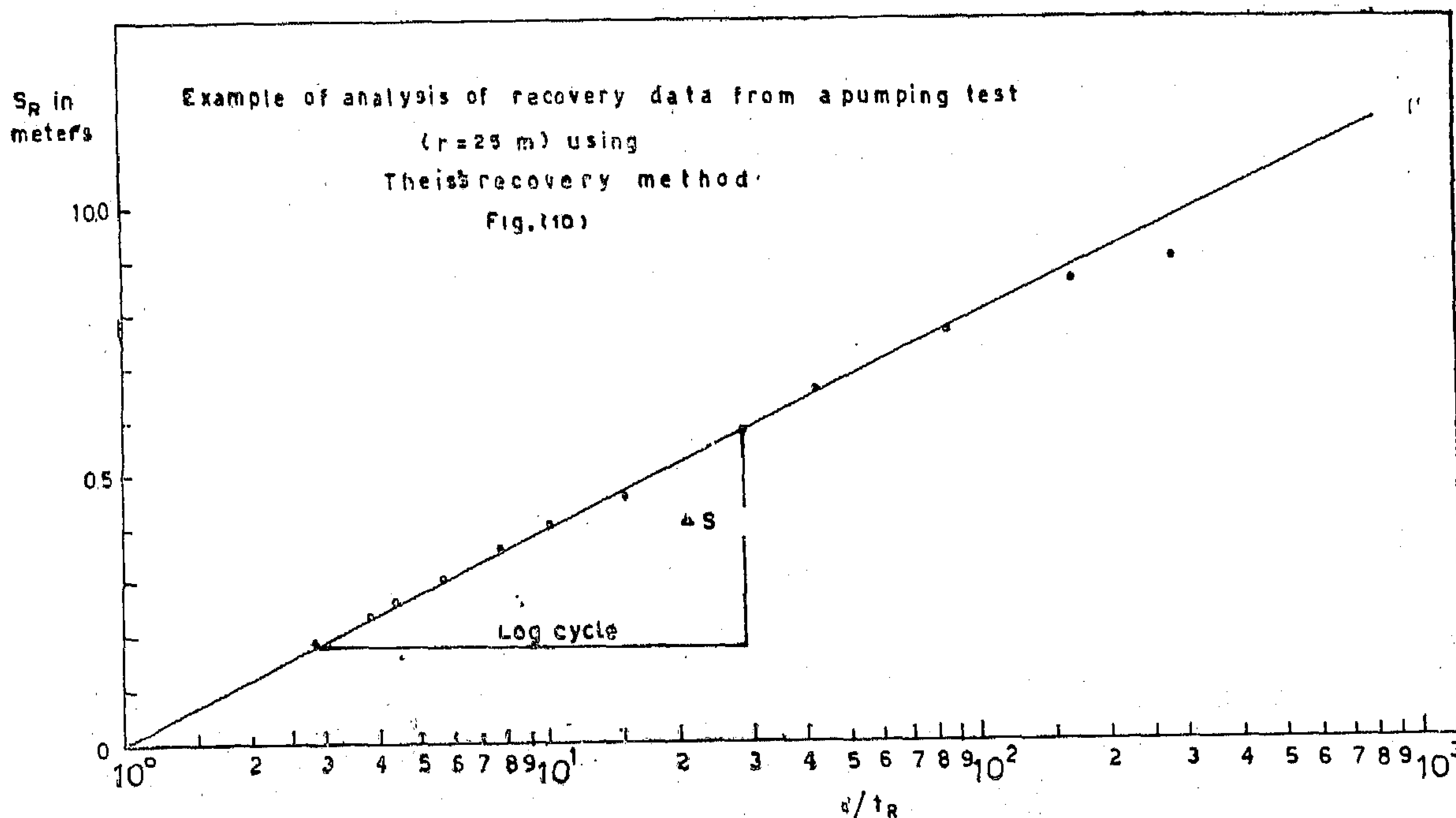
Remarks:

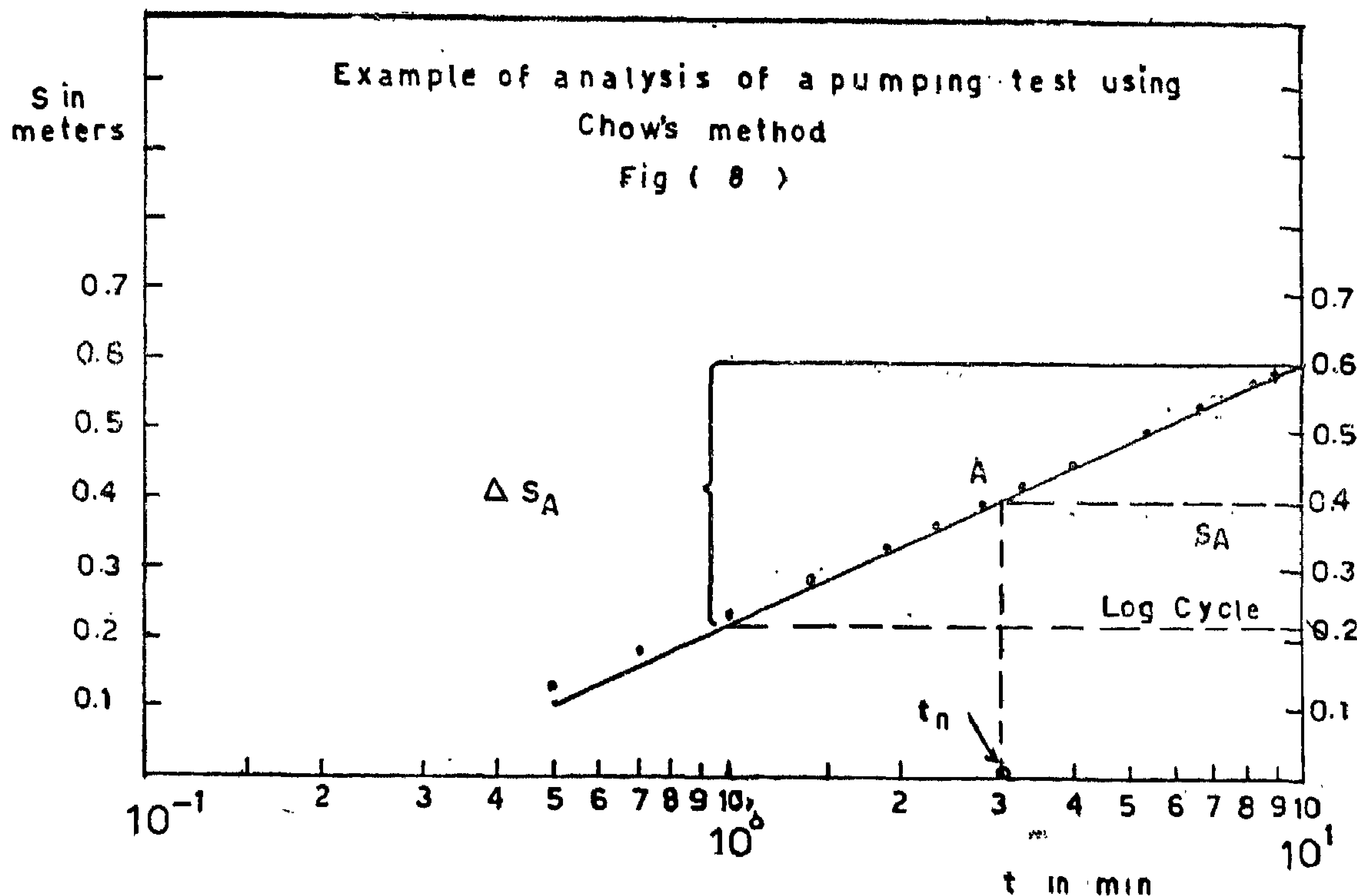
— No value for S' can be obtained with this method.

— When S' and S'_R are constant but unequal the straight line through the plotted points intercepts the time axis where $S_R = 0$ at a point $t/t_R = (t/t_R)_0$ at this point Eq. (16) becomes :

$$0 = \frac{2.30\,Q}{4\pi kD}\left(\log\left(\frac{t}{t_R}\right)_0 - \log\left(\frac{S'}{S'_R}\right)\right)$$

Because $2.30Q/4\pi KD \neq 0$ it follows that $\log(t/t_R)_0 - \log(S'/S'_R) = 0$ hence $(t/t_R) = (S'/S'_R)$ which determines the relative change of S'.





This being the so-called recovery of the well. The rise of the water can be measured as residual drawdown S_R., i.e. as the difference between the original water level prior to pumping and the actual water level measured at a certain moment t_R since pumping stopped, Fig. (9).

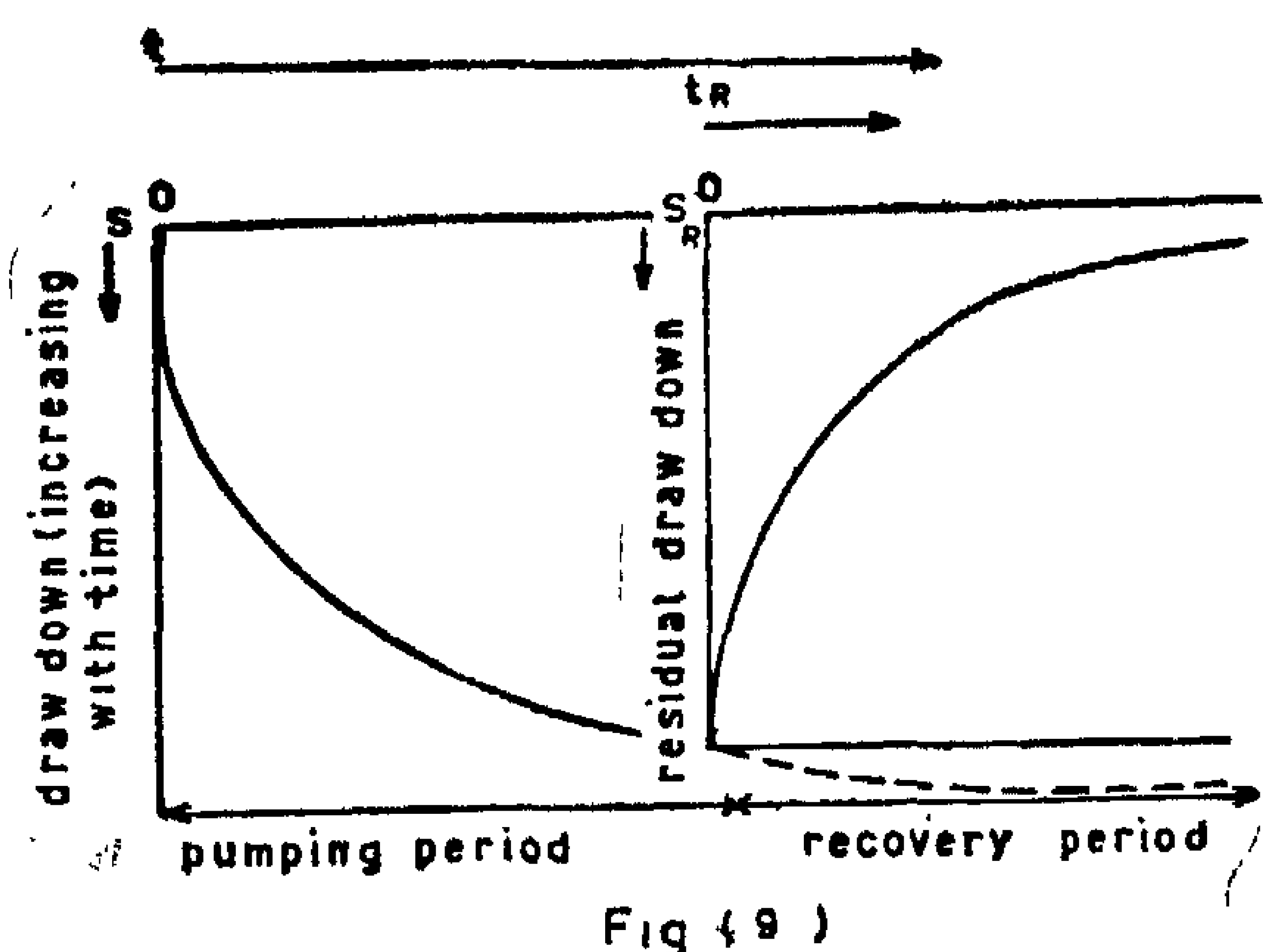


Fig (9)
Schematic time - draw down / residual draw down diagram.

The data obtained during the recovery permit the calculation of the KD, thus giving a check on the results of the analysis of the data obtained during the pumping test period. Moreover, the recovery method has the advantage that the rate of recharge Q is constant and equal to the mean rate of discharge Q during pumping. This means that drawdown variations resulting from slight differences in the rate of discharge pumping do no occur during recovery.

The Theis recovery method can be used to calculate hydrogeological parameters of an aquifer if the assumptions and conditions of Theis method are satisfied.

The residual drawdown S_R , during recovery period is, according to Theis (1935) given by

$$S_R = \frac{Q}{4\pi kD}\left(\ln\frac{4kDt}{r^2 S'} - \ln\frac{4kDt_R}{r^2 S'_R}\right) \quad (16)$$

where

S_R = residual drawdown in m

r = distance in m from pumped well to observation well.

The data of at least three piezometers are needed to get reliable results.

If the drawdown in the different piezometers is not measured at the same time, the drawdown at the chosen moment has to be interpolated from the time- drawdown curve of each piezometer used in procedure 1.

This procedure should be repeated for several values of t. The values of KD and S′ calculated for different values of t should agree closely.

Procedure 3 :

All the data of all piezometers can be used in one graph. If on single logarithmic paper S is plotted versus t/r^2 (t/r^2 on the logarithmic axis), a straight line is drawn through the plotted points and the intercept with the zero drawdown axis is determined, Fig. (7). The coordinates of this point are S = O and $t/r^2 = (t/r^2)_o$

Following the same line of reasoning as in procedure 1, the following formula are derived.

$$S' = 2.25\,KD\,(t/r^2)_o \qquad (12)$$

and

$$KD = \frac{2.30\,Q}{4\pi \Delta S} \qquad (13)$$

The numerical values of $(t/r^2)_o$ and Δ S are determined from the graph and KD and S′ are calculated from Eqs. (13, 12).

C. **Chow's method (1952) :**

Chow (1952) developed a method which has the advantage of avoiding the curve fitting of the Theis method and not being restricted to small values of r and large values of t as in Jacob's method. The same assumptions and conditions should be satisfied as for Theis method because this method is directly based on the Theis Eq. (5).

To find the values of w(u) and u corresponding with the drawdown S measured at a certain moment t, Chow (1952) introduced the function

$$F(u) = \frac{W(u)\, e^u}{2.30} \qquad (14)$$

where F (u) can easily be calculated as shown below.

The relation between F (u), W(u) and u is given in walton (1962).

Procedure :

Plot for one of the piezometers the drawdown S versus the corresponding time t on a single logarithmic paper (t on logarithmic scale).

Select an arbitrary point A on the curve through the plotted points and draw through A a tangent to the curve.

Read on the S-axis the drawdawn value for A, S_A as well as the slope of the tangent line i.e. the drawdown difference ΔS_A per log cycle of time, Fig. (8).

Calculate the value F (U) for the point A from the following equation:

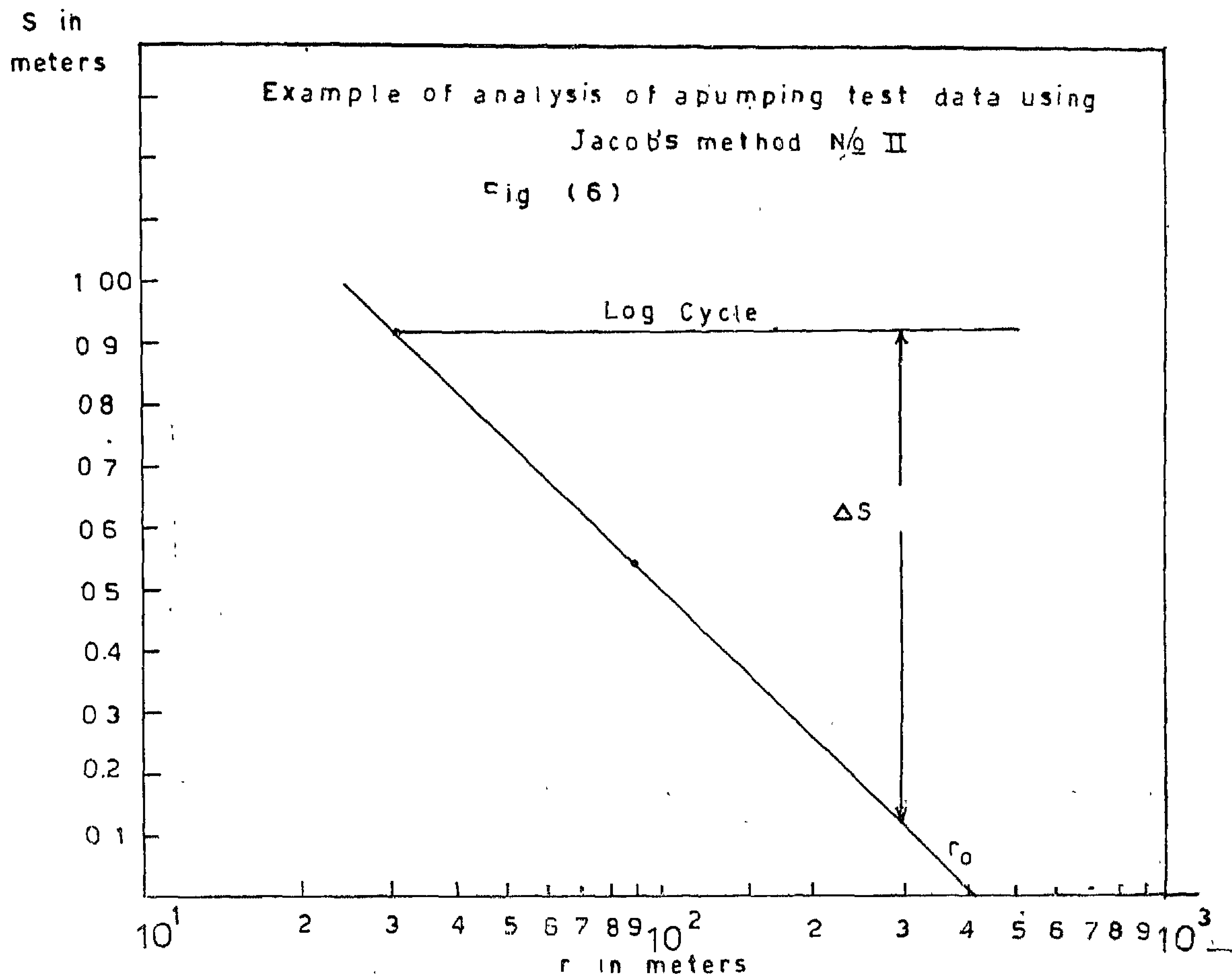
$$F(U) = \frac{S_A}{\Delta S_A} \qquad (15)$$

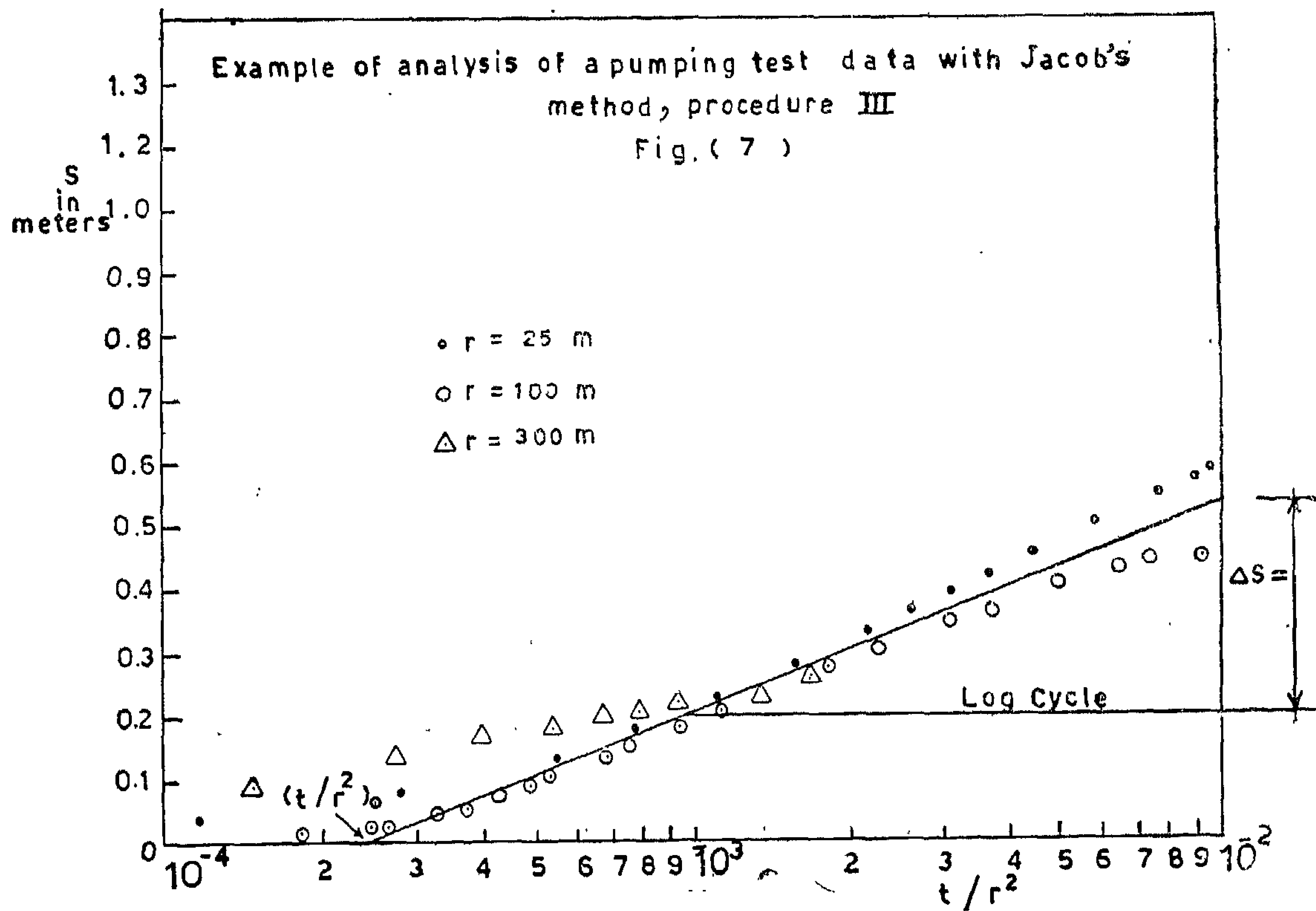
Knowing the values of F (U), find the corresponding values of W (U) and U from the corresponding table.

Record the value of t_A from the time-axis of the observed data curve and substitute the appropriate numerical values into Eqs. (5 & 6) to solve for KD and S′

D. **Theis's Recovery method (1935) :**

After pumping has been shut down the water level will stop dropping and instead rise again to its original position.


S in meters
Example of analysis of apumping test data using Jacob's method N/o II
Fig (6)
Log Cycle
ΔS
r0
r in meters


Example of analysis of a pumping test data with Jacob's method, procedure III
Fig. (7)
S in meters
• r = 25 m
○ r = 100 m
△ r = 300 m
ΔS =
Log Cycle
(t/r²)₀
t / r²

and because $\frac{2.30\ Q}{4\Pi\ KD} \neq O$, it follows that

$$\frac{2.25\ KDt}{r^2\ S'} = 1$$

or

$$S' = \frac{2.25\ KDt_o}{r^2} \qquad (8)$$

If $t/t_o = 10$ and hence $\log t/t_o = 1$, S can be replaced $\triangle$ S, i.e. by the drawdown difference per log cycle of time and it follows that

$$KD = \frac{2.30\ Q}{4\Pi \Delta S} \qquad (9)$$

It will be noticed that $\triangle S = \frac{2.30\ Q}{4\Pi\ KD}$ is the expression for the slope of the straight line. This means that when a straight line has been fitted through the plotted points, the value of t_o is determined as well as $\triangle$ S Fig. (5) and the following assumptions and conditions should be satisfied :

— The same conditions as for the Theis method.

— The values of u are small ($u \angle 0.01$), i.e. r is small and t is large.

The condition that u is small will be satisfied in confined aquifers for moderate distances from the pumped well within an hour or less.

Procedure 1 :

Plot for one of the piezometers (r = const) the values of S versus the corresponding time t on a single logarithmic paper (t on logarithmic scale), and draw straight line through the plotted points, Fig (5).

Extend the straight line till it intercepts the time axis S = O, and read the value t

Determine the slope of the straight line, i.e. the drawdown difference $\triangle$ S per log cycle of time.

Substitute the values of Q and t_o calculate S′ from Eq. (8).

This procedure should be repeated for all available piezometers i.e. for different values of r. There should be a close agreement between the calculated KD-values, as well as between those of S′

When the values of KD and S′ are determined they are introduced into the equation $U = r^2 S'/4KDt$ to check if $U \angle 0.01$, which is a condition for the applicability of the Jacob method.

Before being substitueed into Eqs. (8, 9) all numerical values should be expressed in the same set of units.

Procedure 2.

Identical procedure can be followed by plotting on a single logarithmic paper S versus r (r on logarithmic scale) for t = constant.

Again a straight line is fitted through the plotted points and extended till it intercepts r-axis where S = O (Fig. 6). The interception point has the coordinates S = O and $r = r_o$ (=radius of influence at the chosen moment t). Following the same line of reasoning as above, the following equations are derived

$$S' = \frac{2.25\ KDt}{r_o^2} \qquad (10)$$

and

$$KD = \frac{2.30\ Q}{2\Pi \Delta S} \qquad (11)$$

As in procedure 1 the values of r_o and $\triangle$ S are read from the graph and using equations 11, 10 the values of KD and S′ can be calculated.

As the time of pumping extends the effects of such flow conditions are minimized and closer agreement may be attained.

B. Jacob's method (1946) :

Jacob method (1946) is also based on Theis formula, however, the conditions for its application are somewhat more restricted than for the Theis and Chow methods.

In Theis formula, Eq. (5), the exponential integral can be expanded in a convergent series, so that the drawdown S may be writien as

$$S = \frac{Q}{4 \pi K D} \left(-0.5772 - \ln u + u - \frac{u^2}{2.2!} + \frac{u^3}{3\,3!} \ldots\ldots \right)$$

From $U = \frac{S' r^2}{4KDt}$ it will be seen that u decreases as the time of pumping increases.

Accordingly, for large values of t or small values of r the terms beyond ln u in the series of the above equation become negligible.

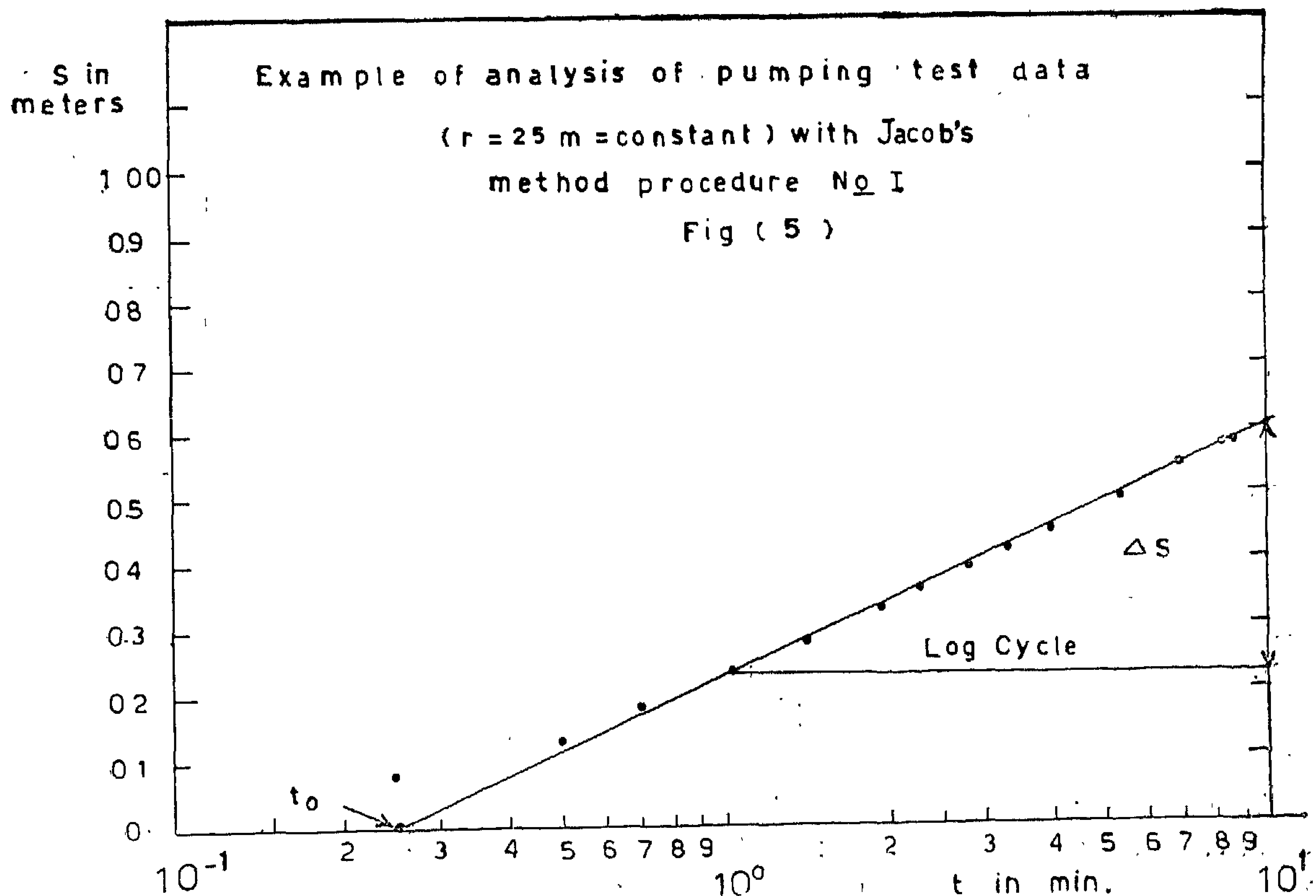
So for small values of ($U \angle 0.01$) the drowndown can be expressed by the following frmoula :

$$S = \frac{2.30\,Q}{4 \pi K D} \log \frac{2.25 K D t}{r^2} \qquad (7)$$

Therefore, a plot of drawdown S versus the logarithm of t forms a straight line, Fig. (5). This line is extended till it intercepts the time-axis where S = O, so the interception point has the coordinates S = O and t = to

Substitution of these values into Eq. (7) gives .

$$O = \frac{2.30\,Q}{4 \pi K D} \log \frac{2.25 K D t_0}{r^2 S'}$$



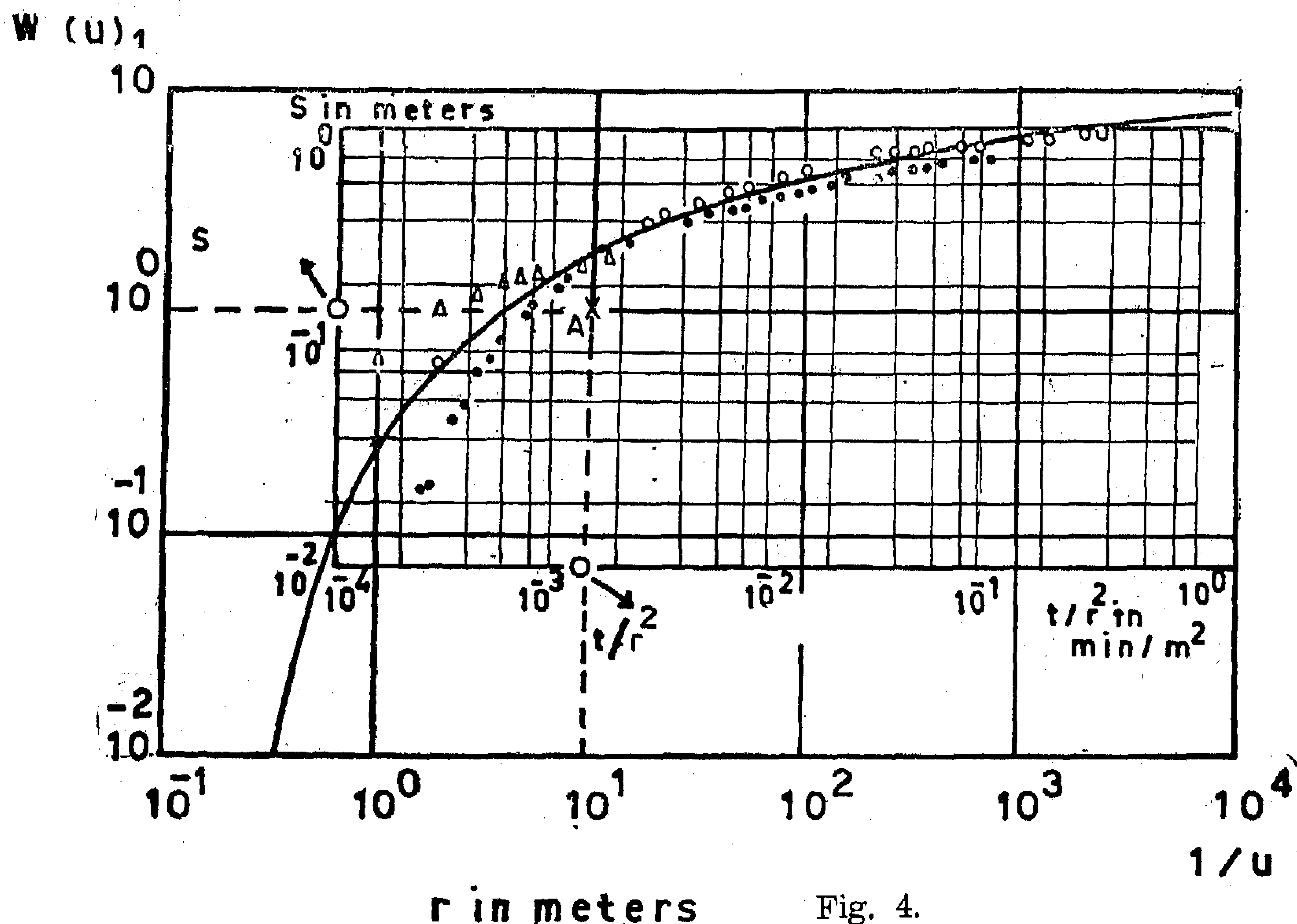


Fig. 4.

of graph paper and determine the coordinates W (u), 1/u, S and t/r^2 for this match point, Fig. (4).

Notice that it is not necessary for the match point to be located along the type curve.

In fact calculations are greatly simplified if the point is selected where the coordinates of the type curve are

W (u) = 1 , 1/U = 10. Substitute the values of W (u), S and Q into Eq. (5), and solve for KD.

$$KD = \frac{Q}{4 \Pi S} W(u).$$

cal culate S' by substituting the values of KD and t/r^2 into Eq. (6).

Remarks :

It should be remembered that in applying the Theis-curve method, and consequently all type-curve methods, less weight in general should given to the early part of the data since these data may not closely represented by the theoritical drawdown equation on which the type curve is based.

The theoritical drawdown equation are based, among other things, on the assumptions that the well discharge remained constant and the release of the water stored in the equifer is immediate and directly proportional to the rate of decline of the pressure head. In fact, there may be a time-lag between the pressure decline and the release of stored water initially also the well discharge may vary as the pump is adjusting itself to the changing head. This causes probable initial disagreement between theory and actual flow conditions.

non-steady state of Theis equation which was derived from the analogy between the flow of ground water and conduction of heat, may be written as :

$$S = \frac{Q}{4\pi KD}\int_{u}^{\infty}\frac{e^{-y}\,dy}{y} = \frac{Q}{4\pi KD}\,W(u) \quad (5)$$

where $U = \frac{r^2 S'}{4\,KDt}$

S = the drawdown in meters measured in a piezometer at a distance r in meters from the pumped well.

Q = the constant well discharge in m^3/day.

S′ = dimensionless storage coefficient and equal to

$$S' = \frac{4\,KDtU}{r^2} \quad (6)$$

KD = Transmissivity of the aquifer in m^2 / day.

t = time in days since pumping started.

W (u) = Theis well function.

The values of W (u) as u varies are given in Walton (1962). From Eq. (5) it will be seen that, if S can be measured for one or more values of r and for several values of t, and if the well discharge Q is known, S′ and KD can be determined. The presence of two unknowns and the nature of exponential integral makes it impossible to effect an explicit solution. However, several approximate graphical solutions have been developed. Besides the general assumptions mentioned earlier the following limiting conditions should be satified:

— The flow to the well is in unsteady state, i.e. the drawdown differences with time are not negligible nor is the hydraulic gradient constant with time.

— The water removed from storage is discharged instantaneously with decline of head.

— The diameter of the pumped well is very samll, i.e. the storage in the well can be neglected.

Procedure:

Type-curve, of the Theis well function prepared on a double logarithmic paper of values W(u) against the arguments (u) can be used, Fig. (3).

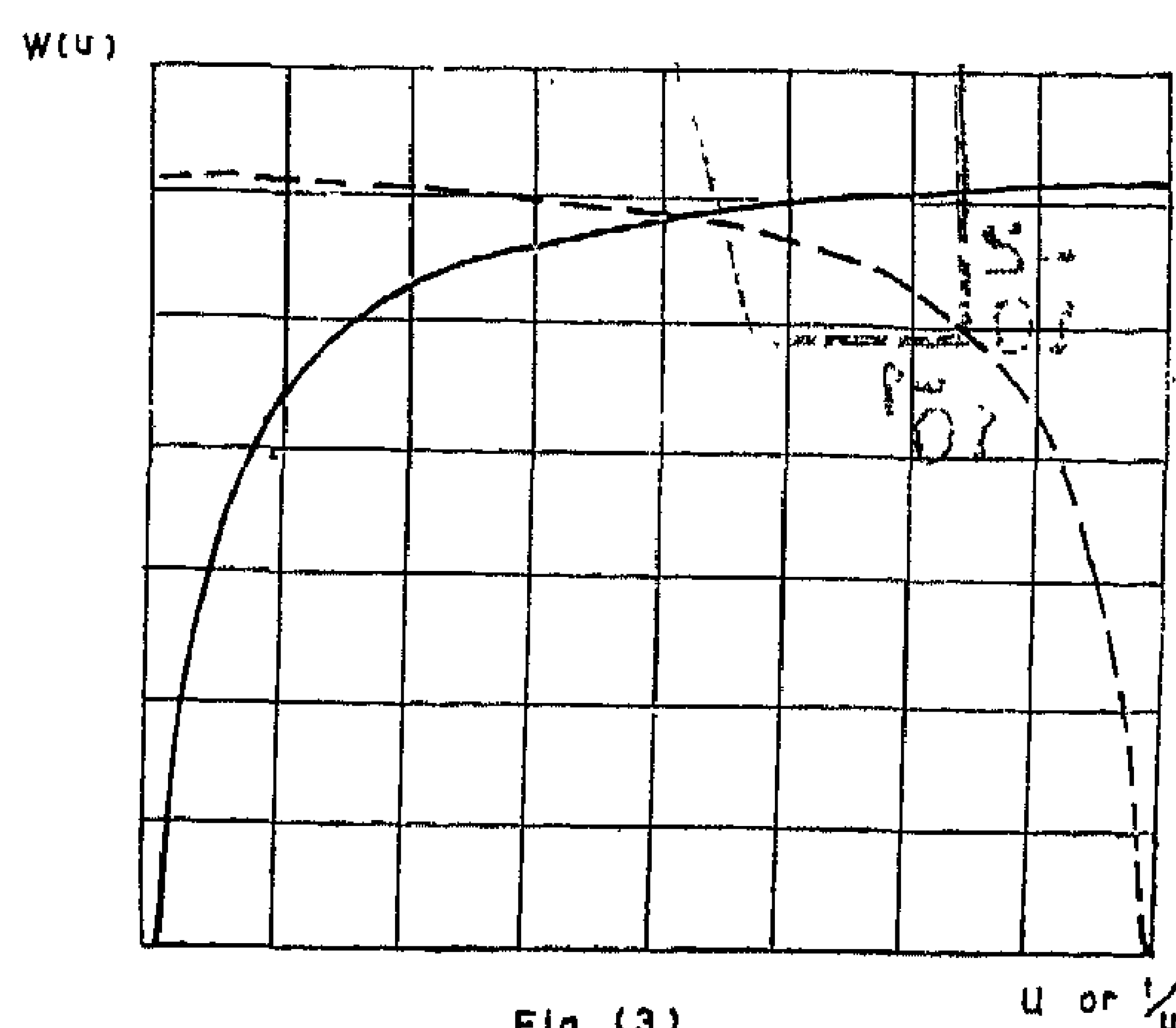


Fig (3)

Theis's Type . Curve W(u) versus $\frac{1}{u}$ (Log-Log Scale)

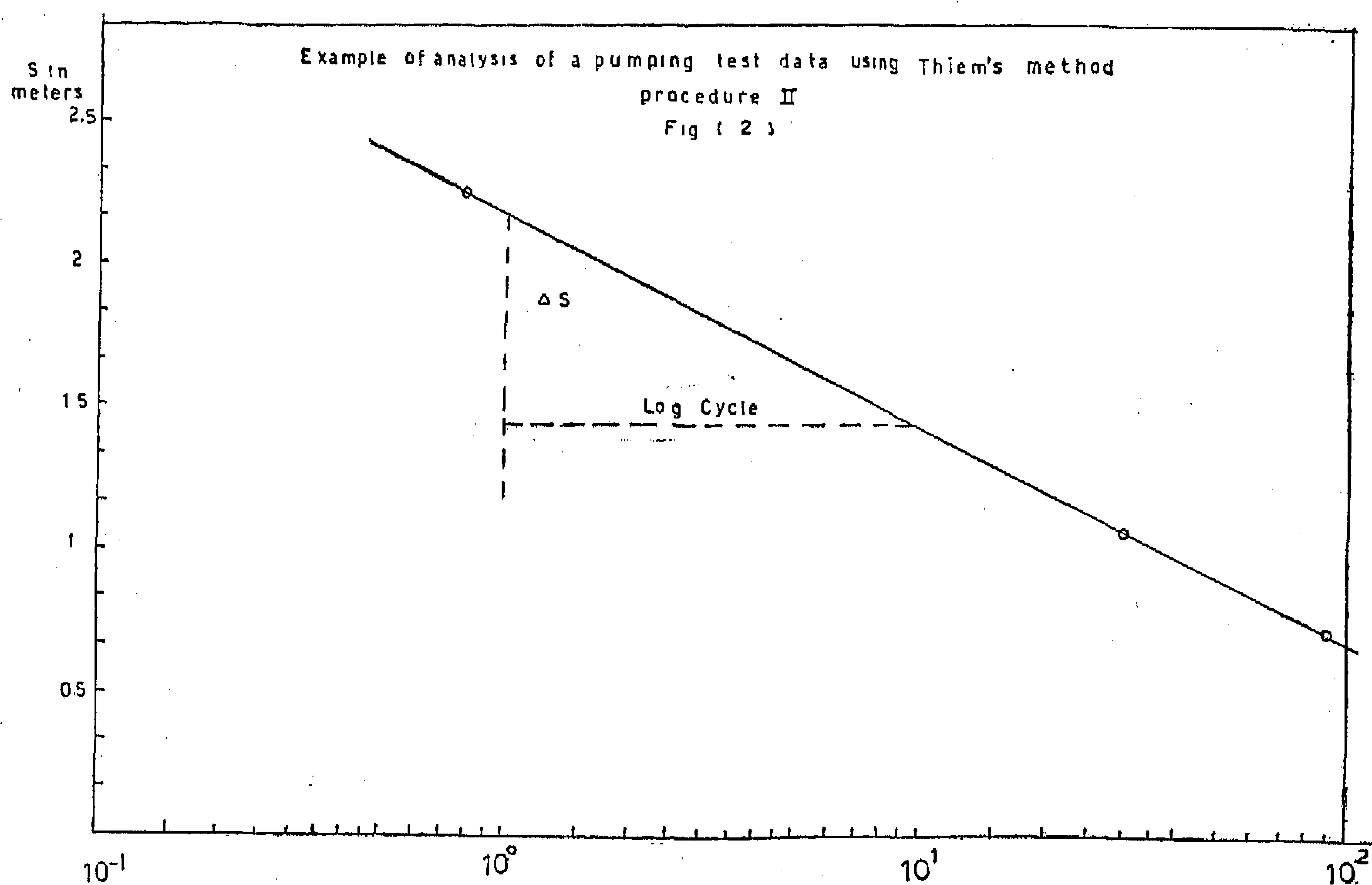
Theis's Type . Curve W(u) Versus u (Log-Log Scale)

Plot the values of S against t/r^2 on a sheet of logarithmic paper of the same scale as that used for the type curve. For this procedure the data from all available piezometers preferably must be used.

— The curve of the observed data will be simillar to the type curve.

— Place the observed data plot over the type curve and, keeping the coordinate axes of both data plot and type curve parallel, locate the position of best match between the data and the type curve.

Select an arbitrary match point A on the overlapping portion of the two sheets



$$Q = \frac{2\pi KD}{2.30} \Delta S \qquad (4)$$

Substitution the numerical values of Q and Δ S in to Eq. (4) we can compute KD.

Remarks :

Attention should be drawn to the fact that steady flow has been defined here as the situation where variations of the drawdown with respect to time are negligible or where the hydraulic gradient has become constant, here we must recognize that true steady flow, i.e. drawdown variations zero, is impossible in a confined aquifer.

3. Unsteady-state methods.

A. Theis's method (1935) :

The steady-state or Thiem equation is widely applicable in determining permeability. However, field conditions may be such that considerable time is required to reach steady-state flow and this is sometimes considered a more or less serious disadvantage of Thiem method.

A major advance was made by Theis (1936) who was the first to develop a non-steady-state formula which introduces the time factor and the storage coefficient. Theis noted that when a well penetrating an extensive confined aquifer, is pumped at a constant rate, the influence of the discharge extends out-ward with the time.

The rate of decline of head, multiplied by the storage coefficient and summed over the area of influence, equals the discharge. Because of the fact that the water must come from a reduction of storage within the aquifer, the head will continue to decline as long as the aquifer is effectively infinite. Therefore, theoretically, no steady-state flow can exist. The rate of decline, however, decreases continuously as the area of influence expands and will eventually be so small that it becomes negligible which, in practice, is considered to be a steady state. The

value of h , and because the aquifer is confined, no special attention need be given to the choice of the datum plane for elevation, and for practical purposes, equation (1) is commonly written as

$$Q = \frac{2 \pi KD (S_1 - S_2)}{\ln r_2/r_1} \qquad (2)$$

where S_1 and S_2 are the respective steady-state drawdowns in the piezometers in meters and the other symbols are mentioned above.

In cases where only one piezometer at a distance r_1 from the pumped well is available

$$Q = \frac{2 \pi KD (S_w - S_1)}{\ln r_1/r_w} \qquad (3)$$

where S_w is the steady-state drawdown in the pumped well, and r_w is the radius of the pumped well.

Equation (3) is of limited use because local hydraulic conditions in and near the well strongly influence the value of S_w e.g. well losses caused by the flow through the well screen and the flow inside the well to the pump intake.

Therefore equation (3) should be used with great caution and only when other methods can not be applied. Preferably two or more piezometers should be used, located close enough to the pumped well so that their drawdowns are appreciable and can readily be measured.

The following procedure can be used to analysis the pumping test data :

Procedure1 :

Plot the observed drawdowns in each piezometer against the corresponding time on a sheet of single logarithmic paper, the drawdown on the vertical axis on a linear scale and the time on the horizontal axis on a logarithmic scale.

Construct the so-called time - drawdown curve of each piezometer, this being the curve that fits best through the points. It was noticed that for the later time data the curves of different piezometers are running parallel and thus their mutual distance is constant. This means that the hydraulic gradient is constant and that the flow in the aquifer can be considered to be in a steady state.

Substitute the values of the steady-state drawdown S_1 , S_2 of the two piezometers into eq. (2), together with the corresponding values of r and the known value of Q and then solve for KD

Repeating this procedure for all possible combinations of piezometers, theoretically the results should show a close agreement, in practice, the calculations can give more or less different values of KD and one can use the mean as a final result.

Procedure 2 :

Plot on a single logarithmic paper the observed steady state drawdowns of each piezometers against the distance between the pumped well and the piezometers Fig. (2).

Draw the best fitting straight line through the plotted points; this is the so-called distance-drawdown graph.

Determine the slope of this line $\triangle S$ i.e. the difference of maximum drawdown per log cycle of r , giving $r_2/r_1 = 10$ or $\log r_2/r_1 = 1$

In doing so Eq. (2) reduces to :

2. The aquifer is homogeneous, isotropic and of uniform thickness over all the area influenced by the pumping test.
3. Prior to pumping, the piezometric surface is nearly horizontal over the area influenced by the pumping test.
4. The aquifer is pumped at a constant discharge rate.
5. The pumped well penetrates the entire aquifer and thus receives water from the entire thickness of the aquifer by horizontal flow.

It will be clear that the first two assumptions in particular are seldom satisfied in nature. However, slight deviations are not prohibitive to the application of the methods.

2. Steady-state methods

Thiem's method (1906) :

All assumptions and conditions listed above under general assumptions should be satisfied. In addition to these, the flow to the well should be in a steady state.

Theim (1906) was one of the first to utilize two or more piezometers to determined the hydraulic conductivity of an aquifer. He showed that for an aquifer satisfying the above conditions the well discharge can be expressed as

$$Q = \frac{2 \pi KD (h_2 - h_1)}{\ln (r_2/r_1)} \qquad (1)$$

where :

Q — is the well discharge in m^3/day.

K D — transmissivity of the aquifer in m^2/day,

r_1 , r_2 are the respective distances of piezometers from the pumped well in meters.

h_1 , h_2 are the respective elevations of the water levels in the piezometers in meters.

This equation, known as the equilibrium or Thiem's equation enables the transmissivity of a confined aquifer to be determined from a pumped well if the values of h are measured in at least two piezometers.

Since we are more interested in the drawdown, commonly designated by the symbol S fig. (1), than in the absolute

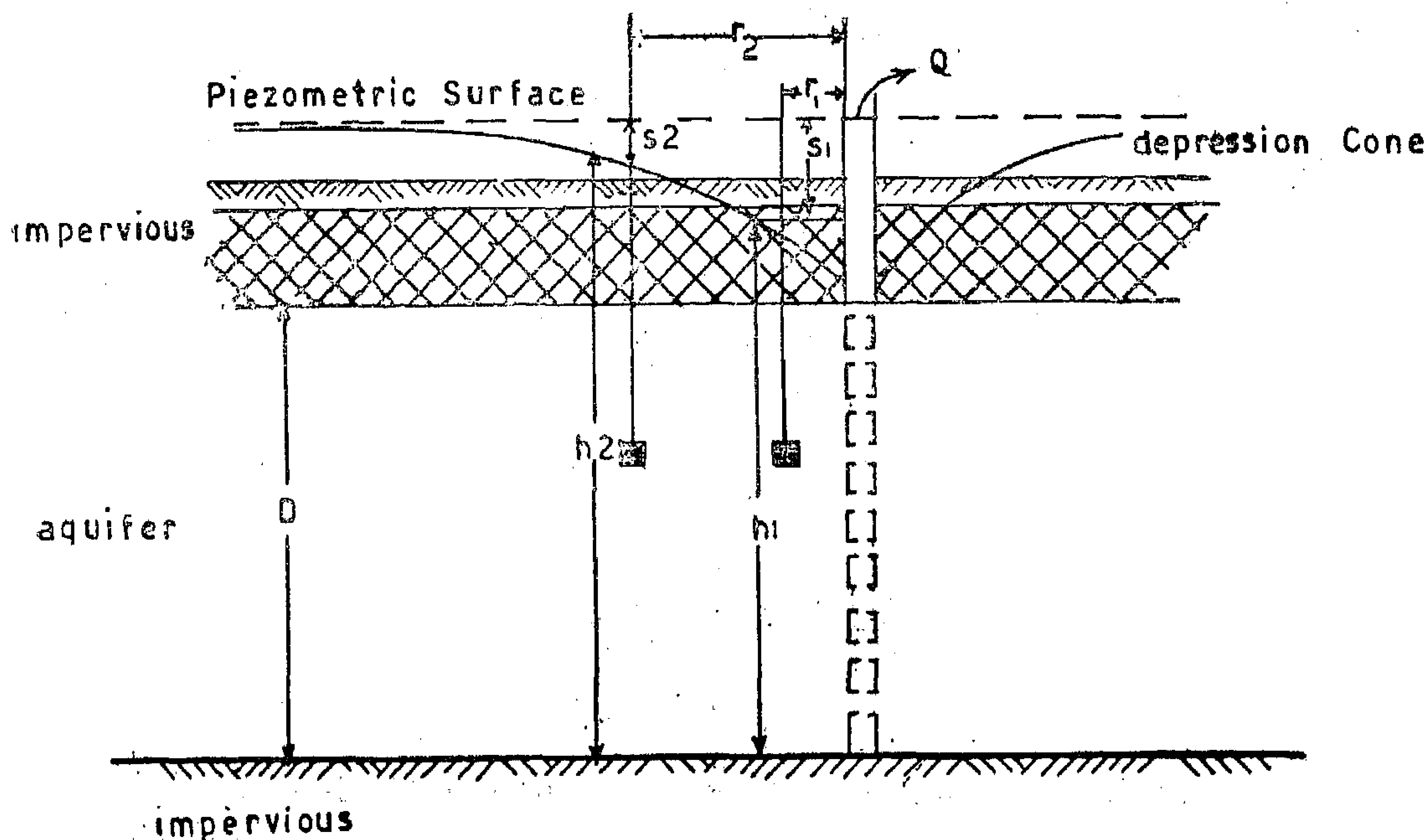


Fig.(1)

Schematic cross-section of a pumped confined aquifer

COMPARISON OF METHODS OF ANALYZING RUMPING TEST DATA

Dr. M. S. SALAWI*

I. ABSTRACT

Nearly all formulas for the analysis of pumping test data are based on certain assumptions and generalizations.

Erroneous results of the computations of the hydrogeological parameters of an aquifer are sometimes ascribed to incorrectness of the formula applied, where as the actual cause of error is the fact that field conditions did not satisfy the assumptions and limitations on which the formula is based.

In this paper the main attention is paid to the conditions and limitations of various methods of analyzing pumping test data. Another task is to bring together and described various methods of analyzing pumping test data scattered here and there over many Journals and handbooks, specially for a confined aquifer, the case which is the most common and dominant over the largest groundwater basin in Egypt the so-called New Valley in Western Desert.

II. INTRODUCTION

A pumping test may serve two main objectives. Firstly, apumping test may be performed in order to determine the hydrogeological parameters of aquifer. Such a test is often called an "aquifer test" because it is the aquifer, rather than the pump or well; which is tested. Well planned and carefully conducted aquifer tests may provide basic information for the solution of many regional, as well as local, ground water problems.

Secondly, a pumping test may provide information about the yield and drawdown of the well. These data can be used for determining the specific capacity or the discharge-drawdown ratio of the well, for selecting the type of pump and for estimating the cost of pumping.

Such a pumping test is sometimes called a "well test" because it is the well rather than the aquifer, which is tested. The principle of an aquifer test is rather simple. From a well, having a screen in the aquifer to be tested, water is pumped during a certain time and at a certain rate. The effect of this pumping on the water table is measured in the pumped well and in some piezometers nearby the well. The hydrogeological parameters of the aquifer are then found by substituting the drawdowns measured in these piezometers, their distance from the pumped well, and the well discharge in an appropriate formula.

III. METHODS OF ANALYSIS

1. **General assumptions**

   Assumptions underlying all methods used in this work are :

1. The aquifer is confined, has a seemingly infinite areal extent.

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of its length, so it was found unreascnable to say that the standard errors of sides of different lengths are the same, and they should be taken as a function of their lengths.

7. It was found that the standard error of the measured sides was not only related to its length, but also to the circumstances & conditions during observation.

8. As a result of the above, it was found reasonable especially when dealing with large geodetic network to apply one of the following methods :

   1. Assuming the standard errors of sides as a function of their lengths, then using the method given by Thornton — Smith in adjusting the net approximately as this method is simple to be used & it takes a less effort & time. After that the values of the variance factors is calculated for angles and sides, from which we can obtain the best estimate of the standard errors which should be taken to the angles & sides, then taking these best values of the standard errors to be used in any of the rigorous methods of adjustment.

   2. Assuming the standard errors of sides as a function of their lengths, then solve with any of the regorous methods to find out the corrections and calculate the value of $\lesssim$Pvv. If the value of $\lesssim$ pvv is close to the number of condition then the solution is satisfactory, if not, calculate the new values of the standard errors as in (2 - a - 1). Instead of resolving the problem from the begining using the new standard errors, it is possible as explained by Madkour [6], first to find out the differences between the old and the new values of the standard errors, then introduce them to the solution to obtain the corresponding over corrections which should be given to the previous values of corrections

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TABLE 4

	solution a		solution b		solution c		solution d		solution e		solution f		solution g		solution 'h'	
	v	σ	v	σ	v	σ	v	σ	v	σ	v	σ	v	σ	v	σ
ANGLES 1	0.047	0·92	0.045	0.92	0·132	0·95	0·096	0·94	0 132	0 95	0·084	0·96	0·129	0·95	0·105	0.97
2	0·695		0.696		0.512		0·600		0·5:3		0·601		0·511		0·552	
3	0·060		0-060		0·004		0·034		0004		0·029		0 002		0·012	
4	0 132		0·134		0·286		0·205		0·287		0·220		0 292		0·266	
5	-0·594		-0 594		-0·678		-0·640		-0·678		-0·643		-0·680		-0·663	
6	-1·099		-1.100		-1 113		-1·100		-1·113		-1·108		-1 116		-1·116	
7	0 791		0 792		0·819		0·804		0·819		0·817		0·824		0·824	
8	-0.234		-0.234		-0·164		-0·200		-0·165		-0·203		-0·165		-0·182	
≨PVV angles	3 242		3.224		3·042		3·083		3·039		3·026		3 061		2·965	
SIDES a	-0·362	0 26	-0 361	0·26	-0·290	0 21	-0·326	0 23	-0·289	0·21	-0·321	0·23	-0·288	0·21	-0 302	0·22
b	0·225		0 226		0 273	0 25	0·250	0 25	0·273	0·25	0·252	0·25	0 273	0·25	0·263	0·25
c	-0·086		-0·086		-0·032	0·13	-0·056	0·19	-0·032	0·14	-0·060	0·18	-0·033	0·13	-0 047	0·16
d	0 358		0 358		0 468	0·31	0·414	0 28	0·468	0·31	0·412	0·28	0·468	0·30	0·441	0·29
e	-0·173		-0 173		-0·115	0·20	-0·145	0·23	-0·115	0·20	-0·146	0·22	-0·115	0·20	-0·129	0·21
f	-0 157		-0 157		-0·116	0·28	-0·137	0·27	-0·116	0·29	-0·137	0·27	-0·117	0·28	-0·127	0·28
≨PVV sides	5.718		5·702		5·930		5·856		5·934		5.929		6·044		5·894	
≨PVV total	8·960		8·926		8·972		8·939		8·973		8·955		9·105		8·859	

2. The corrections obtained from the present solution when compared with the other results obtained from another methods of solutions were approximately very near with very slight differences.

3. The corrections obtained from using the different propositions for the standard errors were not always the same, but they were slightly different. These differences were found in some cases big, but they were a result of using a proposition for the standard error very far from thereal one. This case could be detected if the calculated value of the sum of the weighted aquares of the residuals was found to be very large compared with the total number of conditions.

4. When the method of calculating the best variance (2-a-1) was used, it was seen that,

   a) All the values of the variance factors calculated from the new solutions which uses the best calculated standard errors, were found to be very near to unity. This indicates that the new values of the standard errors were very close to their correct values.

   b) All the values of the standad errors used in the different propositions were changed & found to be approximately identical in all the solution.

   c) The large fluctuations in the sum of the weighted squares of the residuals found when applying the different propositions for weights disappeared. This indicates that the new values of the standard errors were very close to their correct values.

5. When the method of calculating the standard errors of the adjusted values was used and then using these new values in the adjustment (2 - a - 2), The value of the sum of the weighted squares of the residuals was found to be moving far away from its best one, which indicates that this method cannot be used for estimating the best values of the standard errors.

6. It is clear that the error in the measurements of sides is a function

TABLE 5

	solution a		solution b		solution c		solution d		solution e		solution f		solution g		solution h	
	V	σ	V	σ	V	σ	V	σ	V	σ	V	σ	V	σ	V	σ
angles 1	0.688	1.00	0.688	0.60	0.688	0.60	0.688	0.60	0.688	0.60	0.688	0.60	0.688	0.60	0.688	0.60
2	0.478		0.478		0.478		0.478		0.478		0.478		0.478		0.478	
3	0.013		0.013		0.013		0.013		0.013		0.013		0.013		0.013	
4	-0.245		-0.245		-0.245		-0.245		-0.245		-0.245		-0.245		-0.245	
5	-0.471		-0.471		-0.471		-0.471		-0.471		-0.471		-0.471		-0.471	
6	-0.797		-0.797		-0.797		-0.797		-0.797		-0.797		-0.797		-0.797	
7	0.327		0.327		0.327		0.327		0.327		0.327		0.327		0.327	
8	0.105		0.105		0.105		0.105		0.105		0.105		0.105		0.105	
ΣPVV angles	1.739		4.831		4.831		4.831		4.831		4.831		4.831		4.831	
sides a	-0.410	1.00	-0.410	1.00	-0.410	0.35	-0.405	0.58	-0.409	0.34	-0.405	0.26	-0.409	0.07	-0.404	0.16
b	0.271		0.271		0.271	0.42	0.276	0.64	0.270	0.41	0.276	0.29	0.271	0.08	0.277	0.18
c	0.157		0.157		0.157	0.22	0.160	0.47	0.157	0.22	0.160	0.21	0.157	0.04	0.160	0.12
d	0.188		0.188		0.187	0.51	0.194	0.70	0.189	0.49	0.194	0.32	0.189	0.10	0.196	0.21
e	-0.065		-0.065		-0.065	0.33	-0.061	0.56	-0.064	0.32	-0.060	0.26	-0.064	0.07	-0.059	0.15
f	-0.169		-0.169		-0.170	0.47	-0.164	0.68	-0.169	0.46	-0.164	0.31	-0.169	0.09	-0.162	0.20
ΣPVV sides	0.334		0.334		2.600		0.937		2.759		4.547		64.857		12.225	
ΣPVV total	2.073		5.165		7.431		5.768		7.590		9.378		69.688		17.056	

TABLE 6

	solution a		solution b		solution c		solution d		solution e		solution f		solution g		solution h	
	V	σ	V	σ	V	σ	V	σ	V	σ	V	σ	V	σ	V	σ
angles 1	0.688	0.75	0.688	0.75	0.688	0.75	0.688	0.75	0.688	0.75	0.688	0.75	0.688	0.75	0.688	0.75
2	0.478		0.478		0.478		0.478		0.478		0.478		0.478		0.478	
3	0.013		0.013		0.013		0.013		0.013		0.013		0.013		0.013	
4	-0.245		-0.245		-0.245		-0.245		-0.245		-0.245		-0.245		-0.245	
5	-0.472		-0.472		-0.472		-0.472		-0.472		-0.472		-0.472		-0.472	
6	-0.797		-0.797		-0.797		-0.797		-0.797		-0.797		-0.797		-0.797	
7	0.327		0.327		0.327		0.327		0.327		0.327		0.327		0.327	
8	0.105		0.105		0.105		0.105		0.105		0.105		0.105		0.105	
ΣPVV angles	3.061		3.061		3.061		3.061		3.061		3.061		3.061		3.061	
sides a	-0.410	0.23	-0.410	0.23	-0.410	0.23	-0.404	0.23	-0.409	0.23	-0.405	0.23	-0.409	0.23	-0.404	0.23
b	0.271		0.271		0.270	0.28	0.271	0.27	0.271	0.27	0.275	0.25	0.271	0.27	0.277	0.26
c	0.157		0.157		0.157	0.14	0.158	0.15	0.157	0.15	0.159	0.18	0.157	0.14	0.160	0.17
d	0.188		0.188		0.187	0.34	0.188	0.33	0.189	0.34	0.194	0.28	0.189	0.33	0.196	0.31
e	-0.065		-0.065		-0.065	0.32	-0.063	0.30	-0.064	0.22	-0.061	0.22	-0.064	0.21	-0.059	0.22
f	-0.170		-0.170		-0.171	0.31	-0.168	0.29	-0.169	0.31	-0.164	0.27	-0.169	0.31	-0.162	0.29
ΣPVV sides	6.137		6.137		5.995		5.989		5.998		6.006		6.180		5.967	
ΣPVV total	9.198		9.198		9.056		9.050		9.059		9.067		9.241		9.028	

7. Table (7), represents the corrections obtained when using the standard errors which were calculated for the adjusted values in re-adjusting the observed values as in (2 - a - 2).

From the given tables it is seen that :

1. The corrections obtained from the present solution were applied directly to the observed angles and sides, whereas the solution given by Murphy provides corrections which need conversion.

TABLE 3

	solution a		solution b		solution c		solution d		solution e		solution f		solution g		solution h	
	V	σ	V	σ	V	σ	V	σ	V	σ	V	σ	V	σ	V	σ
ANGLES 1	0.575	1.00	0.633	0.60	0.458	0.60	0.578	0.60	0.458	0.60	0.349	0.60	0.041	0 60	0.161	0.60
2	0.453		0.422		0.478		0.442		0.479		0.532		0.397		0.552	
3	0.097		0.096		0.097		0.096		0.096		0.089		0.206		0.042	
4	-0.189		-0.216		-0.097		-0.182		-0.090		-0.035		0.703		0.179	
5	-0.503		-0.486		-0.539		-0.504		-0.543		-0.571		-0.721		-0.643	
6	-0.906		-0.894		-0.961		-0.912		-0.964		-0.983		-1.276		-1.079	
7	0.343		0.290		0.434		0.338		0.443		0.550		1.046		0.753	
8	-0.073		-0.046		-0.070		-0.059		-0.073		-0.132		-0.184		-0.167	
ΣPVV angles	1.778		4.880		4.028		4.931		5.208		5.632		11.037		7.048	
SIDES a	-0.511	1.00	-0.528	1.00	-0.429	0.35	-0.486	0.58	-0.426	0.34	-0.414	0.26	-0.199	0.07	-0.328	0.16
b	0.014		0.121		0.207	0.42	0.163	0.64	0.209	0.41	0.208	0.29	0.273	0.08	0.254	0.18
c	0.046		0.058		0.044	0.22	0.062	0.47	0.043	0.22	0.008	0.21	-0.065	0.04	-0.032	0.12
d	0.480		0.497		0.534	0.51	0.523	0.70	0.533	0.49	0.469	0.32	0.460	0.10	0.452	0.21
e	-0.143		-0.136		-0.091	0.33	-0.114	0.56	-0.091	0.32	-0.129	0.26	-0.133	0.07	-0.124	0 15
f	-0.183		-0.185		-0.114	0.47	-0.148	0.68	-0.114	0.46	-0.141	0 31	-0.137	0.09	-0.125	0 20
ΣPVV sides	0.565		0.597		4.173		1.420		3.193		5.597		47.354		11.741	
ΣPVV total	2.343		5.477		8.201		6.351		8.401		11.229		58.391		18.789	

TABLE 7

	solution c		solution c1	
	V	σ	V	σ
angles 1	0.458	0.60	0.460	0.39
2	0.478		0.485	0.39
3	0.097		0.191	0.38
4	-0.097		-0.201	0.44
5	-0.539		-0.667	0.42
6	-0.961		-0.823	0.30
7	0.434		0.519	0.36
8	-0.070		-0.165	0.39
ΣPVV angles	4.028		8.964	
sides a	-0.429	0.35	-0.433	0.18
b	0.207	0.42	0.230	0.20
c	0.044	0.22	0.058	0.14
d	0.534	0.51	0.469	0.23
e	-0.091	0.33	-0.147	0.19
f	-0.114	0.47	-0.161	0.22
ΣPVV sides	4.173		12.579	
ΣPVV total	8.201		21.540	

3. Table (3), represents the corrections obtained when using Lilly's solution & the different proposition given for the standard errors.

4. Table (4), represents the corrections obtained when using Lilly's solution & the best estimates of the standard errors as suggested in (2-a-1).

5. Table (5), represents the corrections obtained when using Thornton - Smith solution & the different propositions given for the standard errors.

6. Table (6), represents the corrections obtained when using Thornton-Smith solution & the best estimates of the standard errors as suggested in (2 - a - 1).

RESULTS AND CONCLUSIONS

The results obtained from the present solution, and the other solutions using the method given by Lilly's and Thornton Smith, were tabulated according to the following classifications :

1. Table (1), represents the corrections obtained when using the present method of solution & the different propositions given for the standard errors of the measured angles and sides.

TABLE

	solution a		solution b		solution c		solution d		solution e		solution f		solution g		solution h	
	V	б	V	б	V	б	V	б	V	б	V	б	V	б	V	б
ANGLES 1	0 570	1 00	0·580	0 60	0·496	0·60	0·556	0·60	0·492	0·60	0·489	0·60	0·055	0 60	0·377	0 60
2	0 577	1 00	0·582	0 60	0 550	0 60	0 573	0 60	0 548	0·60	0·530	0·60	0·015	0 60	0 434	0·60
3	0 016	1·00	0 066	0 60	0·204	0 60	0·024	0 60	0 217	0·60	0 343	0 60	1·129	0 60	0 627	0·60
4	-0 229	1·00	-0·1 60	0 60	-0 315	0 60	-0 218	0 60	-0·323	0 60	-0·425	0·60	-0·255	0·60	-0 503	0 60
5	-0·603	1·00	-0 622	0 60	-0·563	0 60	-0 601	0·60	-0·561	0 60	-0 541	0 60	-0·943	0·60	-0 539	0 60
6	-0 685	1·00	-0·652	0 60	-0 827	0 60	-0 706	0 60	-0·835	0 60	-0 877	0 60	-1·422	0·60	-1 085	0 60
7	0·144	1·00	·0 099	0 60	0·206	0·60	0 128	0·60	0,216	0 60	-0 327	0·60	1,283	0·60	0 583	0 60
8	0·008	1·00	0 039	0·60	0·048	0·60	0.043	0·60	0,044	0·60	-0·046	0·50	-0 054	0·60	-0·095	0·60
ΣPVV angles	1.565		4.245		4.819		4.342		4.871		5.524		16·407		7·765	
SIDES a	-0·211	1·00	-0·199	1·00	-0·244	0·35	-0·215	0·58	-0 246	0·34	-0,256	0,26	-0·243	0.07	-0·276	0.16
b	0 500		0·498		0·480	0·42	0·492	0·64	0 480	0·41	0·495	0·29	0·466	0.08	0 489	0·18
c	0·268		0·289		0·159	0·22	0·245	0·47	0·156	0·22	0·156	0·21	-0 006	0.04	0·077	0 12
d	0·346		0·353		0·256	0·51	0·318	0·70	0·255	0·49	0·285	0·32	0·323	0.10	0·273	0·21
e	-0 231		-0·239		-0·235	0·33	-0·238	0·56	-0·233	0·32	-0·209	0·26	-0·109	0.07	-0·180	0·15
f	-0·525		-0·566		-0·556	0·47	-0·564	0·68	-0·550	0·46	-0·438	0·31	-0·219	0.09	-0·340	0·20
ΣPVV SIDES	0·817		0·872		4·472		2·087		4·702		7·903		61·266		16·442	
ΣPVV TOTAL	2·382		5·117		9·291		6·429		9·573		13·427		77·673		24·207	

2. Table (2), represents the corrections obtained when using the present method & the best estimates of the standard errors as suggested in (2-a-1).

TABLE 2

	solution a		solution b		solution c		solution d		solution e		solution f		solution g		solution h	
	V	б	V	б	V	б	V	б	V	б	V	б	V	б	V	б
ANGLES 1	0·495	0·83	0·495	0·83	0·376	0·91	0·444	0·87	0·376	0.92	0·430	0·91	0·323	1,03	0·393	0.95
2	0·523		0·523		0·455		0·490		0.454		0.476		0.401		0·450	
3	0·448		0·448		0·573		0·506		0·574		0·549		0·666		0·489	
4	-0·531		-0·531		-0·469		-0·505		-0·469		-0·520		-0·475		-0·497	
5	-0·534		-0·534		-0·532		-0·528		-0·532		-0·528		-0·555		-0·534	
6	-0 884		-0·885		-1·072		-0·974		-0·074		-1·001		-1·157		-1·059	
7	0·384		0·384		0·535		0·451		0·536		0·487		0·665		0·544	
8	-0 102		-0·102		-0·067		-0·086		-0·067		-0·094		-0·090		-0·088	
ΣPVV angles	3·243		3·240		3·131		3·165		3·126		3·053		2·886		2·970	
SIDES a	-0·271	0 33	-0.271	0·33	-0·273	0·26	-0·272	0·29	-0·273	0·26	-0·276	0·28	-0·274	0·24	-0·275	0·27
b	0 504		0·504		0·484	0·32	0·495	0·32	0·485	0·31	0·434	0·31	0.484	0·29	0·489	0·31
c	0·147		0·147		0·078	0·17	0·114	0·23	0·077	0·17	0·103	0·23	0·056	0·16	0·036	0·20
d	0·289		0·289		0·262	0·38	0·275	0·35	0·262	0·38	0·274	0·34	0·271	0·36	0·272	0·36
e	-0·194		-0·194		-0·191	0·25	-0·193	0·28	-0·190	0·25	-0·188	0·28	-0·175	0·23	-0·185	0·26
f	-0·367		-0·367		-0·380	0·36	-0·374	0·34	-0·380	0·36	-0·358	0·33	-0·331	0·33	-0·355	0·34
ΣPVV SIDES	5·792		5·707		5·846		5·795		5·851		5·916		6·306		5·974	
ΣPVV TOTAL	9·035		8·947		8·977		8·960		8·977		8·969		9·192		8·944	

2 — a — Weights Calculated for Angles & Sides :

2-a-1- The weights calculated here depends on the method given by Ashkenazi (4), which states that, if the mean square error of the various observed quantities have been based on the average correctly, then Gauss formula for δ_o^2 should produce unity where:

$$\delta_o^2 = \sum P\,VV/nc$$

where $\sum P\,vv$ = Sum of the weighted squares of the residuals

nc = Number of condition.

δ_o^2 = Standard error of an observation of unit weight.

If the value of δ_o^2 is "K" times larger than unity, this means that the initial weights have been overestimated K times, & therefore if the adjustment is redone with the new estimated weights then the new δ_o^2 would equal unity.

It is easy to demonstrate the correctiness of the proposition above. It is clear that the multiplication of the observation equations by the square root of their respective estimated weights turns them all into observations with uniform weight, & standard error of unity. After the adjustment is done, Gauss's formula produces the "unbiased" value of δ_o^2. If the initial estimates of the standard errors were correct &, therefore, the standard error of the unit weight observation equations was indeed unity, then this should show up in the unbiased value of δ_o^2, as calculated by Gauss's formula.

2 — a — 2 — The second method used for calculating the weights is based on the assumption that after adjustment we can calculate new weights for the adjusted values which in case of correlates equals to

$$Q_{la} = P^{-1} - P^{-1} B^T M^{-1} B P^{-1}$$

where ...

Q_{la} = Weight coefficient matrix after adjustment.

P = Weight matrix.

B = Matrix of coefficients of the corrections V

M = Normal equation matrix.

The above equation is derived as follows :

When adjusting by observation equations, we have the case where

$$A X + L = V$$

L = Descripency vector.

V = Correction vector.

A = Matrix of coefficient of the parameters

When adjusting by conditional equations we have the case where

$$B V + W = O \text{ where } W = \text{misclosure}$$

$$\therefore B (AX + L) + W = O$$

$$BAX + B L + W = O$$

but, $BAX = O$

$$BL + W = O$$

$$W = -BL \quad \therefore Q_w = Bp^{-1} B^T = M$$

For the value of the vector K "vector of correlates"

$$K = -M^{-1} W \quad \therefore Q_k = M^{-1} Q_w M^{-1}$$

For the value of V "vector of correction"

$$V = P^{-1} B^T K \qquad Q_v = P^{-1} B^T Q_k B P^{-1}$$

$$Q_{la} = Q_l - Q_v$$

$$\therefore Q_{la} = P^{-1} - P^{-1} B^T M^{-1} PB^{-1} \quad (9)$$

From this above principle a test was done to examine the validity of using the weights calculated for the adjusted values in readjusting the tested Quadrilateral, i.e. the adjustment was carried out using the observed angles & sides & the given weights. Then after the adjustment, another weights for the adjusted values are calculated, according to the above principle. If the value of $\sum$ Pvv is not close to unity another cycle of adjustment is done.

The sin and tan are taken for the computed angles and not for the measured angles. For the quadrilateral ABCD the complete nine conditions are tabulated as follows where M = 206265.

V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_a	V_b	V_c	V_d	V_e	V_f	Abs.
1	1	1	1											$180+E_1-(1+2+3+4)$
		1	1	1	1									$180+E_2-(3+4+5+6)$
				1	1	1	1							$180+E_3-(5+6+7+8)$
-1								$\frac{-M}{a \tan(2+3)}$	$\frac{-M}{b \tan 4}$	$\frac{M}{a \sin(2+3)}$				$O_1-C_1-\frac{1}{3}E_1$
			-1					$\frac{M}{c \sin(2+3)}$	$\frac{-M}{b \tan 1}$	$\frac{-M}{c \tan(2+3)}$				$O_4-C_4-\frac{1}{3}E_1$
		-1								$\frac{-M}{c \tan(4+5)}$	$\frac{-M}{d \tan 6}$	$\frac{M}{e \sin(4+5)}$		$O_3-C_4-\frac{1}{3}E_1$
					-1					$\frac{M}{a \sin(4+5)}$	$\frac{-M}{d \tan 3}$	$\frac{-M}{e \tan(4+5)}$		$O_6-C_6-\frac{1}{3}E_2$
				-1					$\frac{-M}{b \tan 8}$			$\frac{-M}{e \tan(6+7)}$	$\frac{M}{c \sin(6+7)}$	$O_5-C_5-\frac{1}{3}E_3$
							-1		$\frac{-M}{b \tan 5}$			$\frac{M}{f \sin(6+7)}$	$\frac{-M}{f \tan(6+7)}$	$O_8-C_8-\frac{1}{3}E_3$

From the before mentioned conditions we see that :

1. The theory of least squares can be applied as the equations are of the same units.

2. The corrections obtained by the ordinary method of correlates can now be applied directly to the observed angles and sides to obtain their correct values.

2. **Weights Given for Angles and Sides:**

In order to find out the weights which should be given for angles & sides many propositions were investigated & applied to this suggested solution & the solutions given by Lilly [2] & Thornton-Smith [3], taking into consideration that the weigths are inversely proportional to the square of the standard error. The different propositions are as follows :

a) Standard error of side = 1 feet & 1″ for angles.

b) Standard error or side = 1 feet & 0.6″ for angles.

c) Standard error of side = 1 / 200000 of the measured side & 0.6″ for angles.

d) Standard error of side = 1/ 206265 of the measured side

e) Standard error of side = S sin 1″

f) Standard error of side = $\sqrt{S/10^6}$

g) Standard error of side = $S/10^6$

h) Standard error of side = equals to that of the instrument used in measuring the sides which in our example equals to $(1.5 + 2 \times S \times 10^{-6})$. Where S is the measured length.

All the above propositions were investigated by a computer program prepared for the present solution & the solutions given by Lilly's & Thornton-Smith.

1. **Formation of Condition Equations :**

a) **Angles Conditions :**

In the spherical triangle ABC, the observed angles are O_1, O_2, O_3, O_4, the observed sides are a, b, c, and the spherical excess is E . Then the angle condition in triangle ABC could be written as follows :

$$O_1+V_1+O_2+V_2+O_3+V_3+O_4+V_4 = 180 + E_1 \quad \cdots \quad (1)$$

where,

V_1, V_2, V_3, V_4, are corrections to the observed angles.

b) **Length Condition :**

In the same triangle ABC there are two length conditions which could be formed. The method used here for forming the length condition simply states that, the observed spherical angle after subtracting The corresponding spherical excess must equal the angle computed from the measured sides.

These conditions could be written as follows:

$$O_1 + V_1 - {}^1/_3 E_1 = C_1 + \delta C_1 \quad (2)$$

$$O_4 + V_4 - {}^1/_3 E_1 = C_4 + \delta C_4 \quad (3)$$

where,

C_1, C_4 are the computed angles

$\delta C_1, \delta C_4$ are the errors in the computed angles.

Angles 1, 4 were computed from the formula

$$\cos 1 = \frac{a^2 + b^2 - c^2}{2ab} \quad (4)$$

$$\cos 4 = \frac{c^2 + b^2 - a^2}{2cb} \quad (5)$$

But as the measured sides are not completely true, then errors in the computed angles 1,4 could be computed by differentiating equation (4), (5). Taking equation (4) as an example :

$$-\sin 1 . \delta c_1 = \left[\frac{2a}{2ab} - \frac{(a^2+b^2-c^2)}{2a^2b}\right]\delta a + \left[\frac{2b}{2ab} - \frac{a^2+b^2-c^2}{2ab^2}\right]\delta b - \left[\frac{c}{ab}\right]\delta c.$$

$$= \left(\frac{a^2+c^2-b^2}{2a^2b}\right)\delta a + \left(\frac{b^2+c^2-a^2}{2ab^2}\right)\delta b - \left(\frac{c}{ab}\right)\delta c$$

$$= \left(\frac{c\cos(2+3)}{ab}\right)\delta a + \left(\frac{c}{ab}\cos 4\right)\delta b - \left(\frac{\sin 1}{a\sin(2+3)}\right)\delta c$$

$$\therefore \delta c_1 = \left(\frac{Vc}{a\sin(2+3)} - \frac{Va}{a\tan(2+3)} - \frac{Vb}{b\tan 4}\right) 206265 \quad \cdots \quad (6)$$

The same deriviations are applied for C_4 & the conditions 2, 3 became

$$206265\left(\frac{Vc}{a\sin(2+3)} - \frac{Va}{a\tan(2+3)} - \frac{Vb}{a\tan 4}\right) - V_1 = O_1 - C_1 - {}^1/_3 E_1 \quad \cdots \quad (7)$$

$$206265\left(\frac{Va}{c\sin(2+3)} - \frac{Vb}{b\tan 1} - \frac{Vc}{c\tan(2+3)}\right) - V_4 = O_4 - C_4 - {}^1/_3 E_1 \quad (8)$$

ADJUSTMENT & WEIGHING OF DISSIMILAR QUANTITIES

By

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ABSTRACT

After the introduction of the electronic distance measurements technique (E.D.M.), the measuring of the sides of the triangulation network, besides angles, becomes a common routine in geodetic field work. An increase in the accuracy and strength of the network is expected in this technique.

In order to apply the least squares method correctly in the adjustment of nets where their sides and angles are measured, one has to face two problems :

A) The problem of dealing with observed quantities of different physical dimensions.

B) The problem of introducing the correct weights for the observed quantities.

Many authors dealt with these problems, and each author gave different explanation. A new idea is introduced in this paper. It deals with :

1. The formation of the condition equations and how to transfer their form into one having the same physical dimensions.

2. The estimation of the proper weights which should be given for both angles and sides of a single figure, when using angles only or when using angles and sides in a combined solution.

3. The estimation of the proper weights which should be given for angles and sides in geodetic network.

MATERIAL AND METHODS USED

The material used here is a braced quadrilateral investigated some time ago by Murphy [1] (Fig. 1).

The measured angles and sides are as follows :

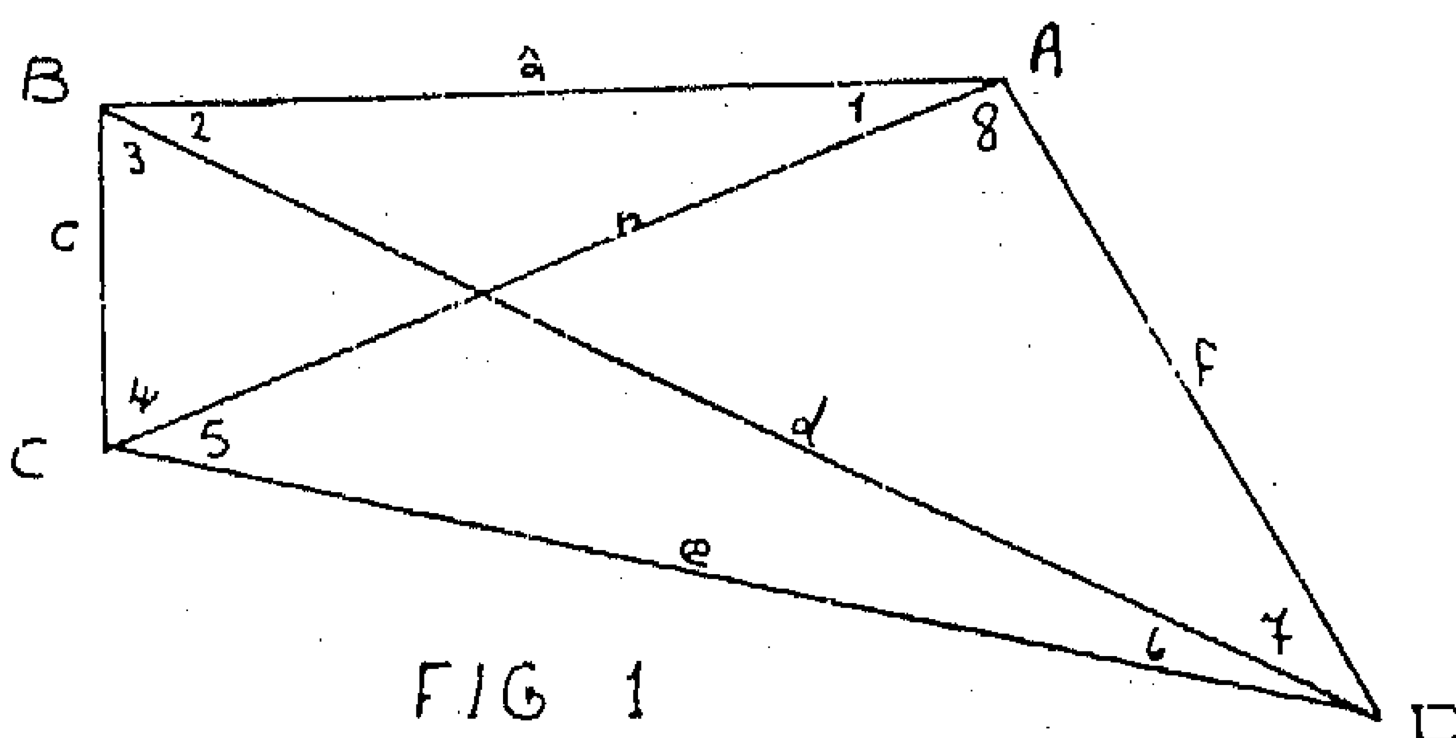


FIG 1

Angle				Side	Length "in feet"
1	32	18	19.3	a	69847. 62
2	63	19	25.7	b	83587. 77
3	27	42	17.9	c	44679. 21
4	56	39	56.9	d	102017. 34
5	77	14	02.9	e	65824. 23
6	18	23	44.3	f	94277. 10
7	41	27	12.9		
8	42	55	02.3		

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وزارة الكهرباء

المؤسسة المصرية العامة للكهرباء

نموذج رائع..
للصمود الاقتصادى

وتسهم فى تحقيق أهم الإنجازات المصرية والعربية وتنفذ أضخم المشروعات الكهربائية والصناعية والميكانيكية .. على أرقى المستويات العالمية

تهتم بالطاقة الكهربائية تدعيماً لبناء دولة عصرية وتعمل على دعمها بكل الإمكانيات والأساليب وصولاً إلى تطور شامل فى مختلف الميادين يتيح لنا كدولة اللحاق بركب العصر ويدفع بنا على طريق الحضارة الحديثة ويهيئ لنا كأفراد أن نستمتع بالحياة وأن نأخذ بما فيها من أساليب الرقى والتمدن .. وذلك بنفسها وبشركاتها الثلاث :

١. الشركة العامة للمشروعات الكهربائية
«إيليجيكت»

٢. شركة مصر للمشروعات الميكانيكية والكهربائية
«كهروميكا»

٣. شركة السد العالى للمشروعات الصناعية والميكانيكية
«هايديلكو»

البترول 

أهم دعامات البناء الاقتصادي

لاشك أن البترول عصب الحضارة ومصدر القوة وأكسير الصناعة ومحرك المواصلات لهذا كان من يملك مصادر البترول يملك كل شيء ... حتى أن اكتشاف البترول في البلاد المتخلفه كان من أهم العوامل التي أفقدت هذه الدولة استقلالها وحريتها وحولتها الى مستعمرات للدول الصناعية الكبرى .

الماضي :

على الرغم أن مصر هي أول دولة عربية اكتشفت البترول وأنتج في أراضيها ، اذا يرجع عهد الصناعة البترولية فيها الى قرن من الزمان . الا أن صناعاتنا البترولية ظلت خاضعة لتحكم الاحتكارات الأجنبية التي لم تكن سوى أدوات في أيدي المصالح الاستعمارية وبالتالي فقد ظل اقتصادنا الوطني في قبضتها تحققه متى شاءت وتصيب حياتنا كلها بالشلل التام .. الا أنها قد نجحت أساسا في تكوين قاعدة عريضة من الكوادر الفنية المدربة ، ولأول مرة استخدمت الغازات البترولية من معامل التكرير لانتاج الكبريت والأسمدة الآزوتية ، فكانت أول منتجات بتروكيماوية تنتج في مصر .. كان هذا هو الموقف الذي واجهته الثورة لحظة قيامها .

الحاضر :

بدأت الثورة بزيادة طاقة التقطير في معمل التكرير الحكومي بالسويس بمقدار مليون طن في العام وانشاء بعض الوحدات الاضافية كوحدة تحسين البنزين وأنشأت معمل تكرير الاسكندرية . وفي عام ١٩٥٣ منحت الحكومة امتيازا للبحث عن البترول للجمعية التعاونية للبترول في بعض مناطق سيناء . وتم الاتفاق في عام ١٩٥٤ مع احدى الشركات الأمريكية (كونورادا) للبحث عن البترول في الصحراء الغربية الا أنها صفت أعمالها في نهاية عام ١٩٥٨ — وكان للنتائج التي حققتها هذه الشركة من أعمالها عوامل هامة ساعدت مصر بعد ذلك في اجتذاب شركات أخرى للبحث عن البترول في الصحراء الغربية . وفي عام ١٩٥٧ تم انشاء الشركة العامة للبترول وكانت أول شركة وطنية عربية في الشرق الأوسط مملوكة للحكومة تمارس نشاط البحث عن البترول وانتاجه . وفي عام ١٩٥٩ تم تأسيس الشركة الشرقية للبترول برأس مال مشترك مع الجانب الايطالي وحصلت على امتياز للبحث عن البترول في بعض مناطق سيناء وخليج السويس .

وبقيام **المؤسسة المصرية العامة للبترول** تغيرت الصورة تماما وسيطرت مصر على صناعاتها البترولية ... وبدأ النهوض بقطاع البترول وفقا لخطة وطنية مرسومة . فتم تدعيم الشركة العامة للبترول واكتشفت حقولا في الصحراء الشرقية . وفي عام ١٩٦٣ ، ١٩٦٤ ، ١٩٦٩ — وبشروط لم يسبق فيها مصر أي بلد منتج للبترول — تم ابرام عقود مشاركة للبحث عن البترول في خليج السويس والصحراء الغربية والدلتا مع ثلاث شركات عالمية .. وبهذا ارتفع حجم الاحتياطي الثابت من البترول وذلك بالرغم من تضاعف حجم الانتاج المحلي من الزيت الخام تضاعفا كبيرا ... بالاضافة الى احتياطي الغازات الطبيعية التي اكتشفت في حقول أبو ماضي وأبو قير وأبو الغراديق وبلغ عدد الحقول المنتجة ١٩ حقلا وصل انتاج الخام منها الى حوالي ١٩ مليون متر مكعب عام ٧١/٧٠ بخلاف انتاج حقول سيناء الذي بلغ ٥ مليون متر مكعب .

ومن أهم الاكتشافات البترولية حقول بلاعيم بري (١٩٥٥) ، بلاعيم بحري (١٩٦١) ، المرجان البحري وهو أكبر الحقول المصرية انتاجا (١٩٦٥) ، العلمين (١٩٦٦) ، يدما (٧١) رزاق ومليحة (١٩٧٢) . وفي مجال الغاز الطبيعي تم اكتشاف أبو ماضي (١٩٦٧) ، أبو قير (١٩٧٠) أبو الغراديق (١٩٧٠) غاز طبيعي وبترول خام . هذا الى جانب بعض الحقول الأخرى على ساحل البحر الأحمر مثل بكر ، كريم ، عامر ، شقير .

ولم يقف البترول عند حد الاكتشافات بل تم تنفيذ مجمع ضخم لتفحيم المازوت لانتاج المنتجات الوسطى (الكيروسين ، والسولار ، الديزل) وبعض الخامات الأساسية في صناعة البتروكيماويات مثل التلوين والبنزول والدوديسيل بنزين وكميات كبيرة من الكبريت . كما تم لأول مرة في مصر انتاج زيوت

التزييت وبعض المنتجات الخاصة مثل المذيبات والأسفلت المنفوخ .

ومع قيام الثورة الصناعية فى البلاد وما صاحبها من تطور واتساع فى الانتاج البترولى تزايد الضغط على الطرق البرية . فكان استخدام خطوط الأنابيب هو الحل الأمثل للمشكلة وتم فى عهد الثورة انشاء شبكة من خطوط الأنابيب تربط السويس بالمستودعات الرئيسية فى القاهرة وشبكة أخرى تربط معمل الاسكندرية بمراكز التوزيع الرئيسية فى المناطق الصناعية بالوجه البحرى وتحقق الأمن على الطرق البرية وخف الضغط على السكك الحديدية وعلاوة على ذلك تحقق خفض ملموس فى تكاليف النقل بفضل ما تتميز به الأنابيب من رخص التكلفة وانتظام التشغيل .

واذا كان البترول هو عصب الحياة.. فالعاملون فى صناعة البترول هم جنود الطليعة فى معركة الانتاج الكبرى التى يخوضها وطننا اليوم .. انهم يسبقون الركب ليوفروا له زاده من الطاقة ليمضى فى انطلاقة . وان كل فرد فى هذه الصناعة ليدرك ضخامة المسئولية المقدسة الموضوعة فى عنقه ..

ولقد استطاع القطاع البترولى بفضل السياسة المدروسة التى رسمها لبناء الأفراد الصالحين أن يرتفع بالعاملين معه الى مستوى مسئوليتهم تجاه مجتمعنا .. ولم تقتصر أهداف هذه السياسة على تخريج الصناع المهرة بل امتدت لتشمل كافة المستويات الاشرافية . والجدير بالذكر أنه يوجد حاليا حوالى ٣٠٠ خبيرا مصريا يعملون فى الدول العربية واليونان وسيلان فى مختلف مجالات هذه الصناعة من انتاج وتكرير وتوزيع ، حتى أن البلاد التى يعملون بها تشهد بكفائتهم العالية فى كل مجالات الصناعة البترولية ...

ويكفى قطاع البترول فخرا أنه بعد عدوان ١٩٦٧ صمد وتمكن من التغلب على صعوبات جمه لم يواجهها قطاع آخر فى مصر ... فقد نجح فى جميع مجالاته وصمد العاملون فيه وتمكنت الصناعة البترولية من القيام بالتزاماتها وبالأعباء التى ألقيت على عاتقها بأمانة وشجاعة فائقة ...

المستقبل :

لما كان البترول موردا للنقد الأجنبى اللازم للتنمية ... كان لابد من مضاعفة الانتاج ـ عدة مرات ـ مع اختيار أحسن الطرق لاستغلال البترول الخام والغازات الطبيعية للحصول على أكبر عائد اقتصادى ممكن . وعلى هذا الأساس وضعت تقديرات خطة الانطلاق فى قطاع البترول متمثلة فى النقاط الرئيسية التالية :ـ

١ ـ زيادة نشاط البحث عن البترول زيادة كبيرة والى أقصى حد ممكن لاستكشاف مصادر جديدة تؤمن احتياطى البترول وترفع معدل انتاجه مع الأخذ فى الاعتبار تغطية معدلات التناقص الطبيعى للحقول المنتجة وفى نفس الوقت مضاعفة المعدلات الحالية للانتاج . ومن المقدر أن يبلغ انتاج الغازات الطبيعية ١٠ من الزيت الخام فى عام ١٩٨٢ .

وقد أظهرت عمليات البحث والحفر فى الصحراء الغربية وخليج السويس وغيرها أخيرا ما يشجع الشركات العالمية على الاقبال للعمل فيها وتعمل مؤسسة البترول على تشجيع ذلك بشتى الطرق . وقد تم عقد ١٤ اتفاقية فى خلال عام ١٩٧٣ والشهور الأربعة الأولى من عام ١٩٧٤ مع شركات أجنبية .

٢ ـ الاستمرار فى البحث عن حقول الغازات الطبيعية وتوقع زيادة الانتاج من الغازات بما يسمح باستخدامها كمادة خام للصناعات المختلفة فضلا على الاستخدامات الأخرى ومن المقدر أن يبلغ الانتاج حوالى ٤٥ مليون طن مليون طن فى عام ١٩٨٢ .

٣ ـ العمل على تنفيذ مشروعات التكرير بما يشبع كافة الاحتياجات المحلية من المنتجات البترولية الرئيسية وتصدير الفائض منها وتحسين مواصفاتها الى الحد المناسب مقارنا بالمستوى العالى وانتاج بعض المنتجات الخاصة مثل زيوت التزييت الخاصة ومذيب الهكسان وغيرها من المنتجات التى تستورد من الخارج .

٤ ـ زيادة الصادرات من الزيوت الخام والمنتجات البترولية والخدمات بالاضافة الى تصدير الفائض من الغازات بعد اسالتها .

٥ ـ تصنيع جزء من فائض النافتا وتحويله الى منتجات وسيطة ثم تصنيعها الى منتجات بتروكيماوية متمثلة فى المطاط الصناعى والألياف الصناعية ومواد البلاستيك وغيرها والتى يتم حاليا استيرادها من الخارج ، وبذلك ترتفع قيمة النافتا الى حوالى ٥ أمثال قيمتها اذا صدرت على هيئة نافتا .

٦ ـ تعزيز وسائل النقل البحرى والبرى والتخزين والتسويق لمقابلة الطفرة المتوقعة فى الانتاج ولضمان تزويد مراكز التكرير الجديدة بحاجتها من البترول الخام ومراكز التوزيع والمستهلكين بحاجتها من المنتجات البترولية .

٧ ـ الاسراع فى تنفيذ مشروع مد خط أنابيب البترول بين خليج السويس والبحر الأبيض المتوسط . هذا وقد تم فعلا تكوين الشركة العربية لأنابيب البترول التى تمتلك المشروع برأس مال مصرى عربى مشترك .

٨ ـ الاهتمام البالغ بالبحوث التطبيقية فى المجالات المختلفة للصناعات البترولية ويحتاج ذلك الى طفرة ثورية من الأجهزة المختصة فى الدول للوصول الى الهدف المنشود .

والأمل فى المستقبل كبير ، ومستقبل مصر البترولى عظيم ، وسيحقق البترول باذن الله الدور الهام الذى ينتظره فى تنمية البلاد اقتصاديا واجتماعيا .

بهجة الأعياد
تزداد مع ...

ابوسمبل

الكينا الحديدية
الممتازة







من خلاصات شركة
« كارلو اربا »

العالمية
للأدوية

الإنتاج الممتاز لشركة :

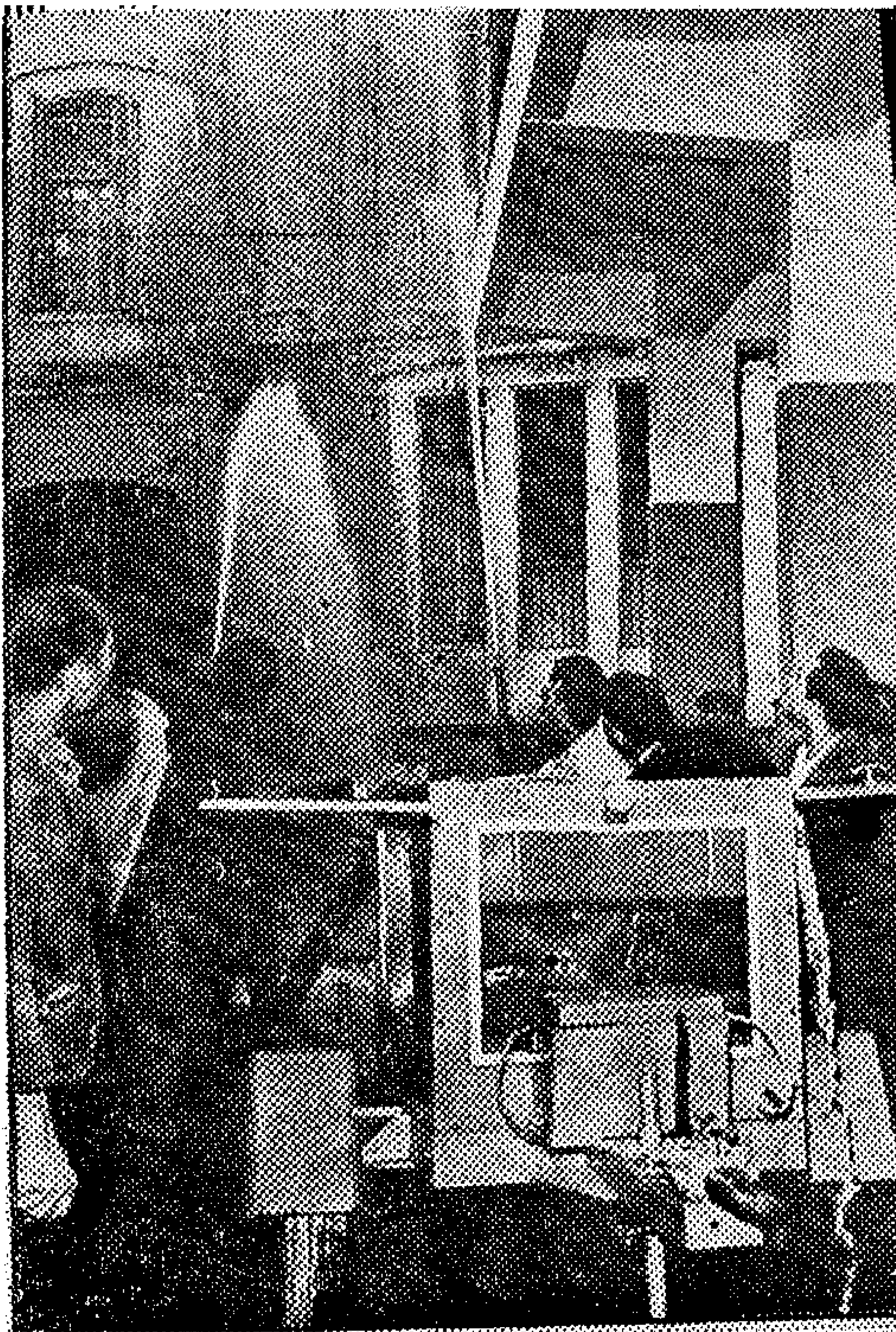
منتجات الكروم والتقطير المصرية

إحدى شركات المؤسسة المصرية العامة للصناعات الغذائية

الشركة المصرية للهندسة والتجارة

« الدغيدى وشركاه »

مهندسون وخبراء متخصصون فى تصنيع وتجميع الطلمبات ذات الضغط العالى للأسواق المحلية والخارجية



- محركات ديزل
  للأغراض الصناعية والنقل
- مجموعات رفع مياه
  لجميع الأغراض
- مجموعات إطفاء حريق
  ميكانيكية نقالى
- تصميم وتنفيذ مشروعات ميكانيكية وكهربائية
  وأعمال متكاملة
- تركيبات محطات قوى ومحطات ضخ مياه.
  « رى وصرف »

القاهرة : ٤٥ شارع شمبليون
تليفون : ٧٢٧٢٦/٧٣٧٣٦/٥٥٨٨٧

شركة الورق الأهلية

إحدى شركات المؤسسة المصرية العامة للصناعات الكيماوية

تقوم بدورها الرائد في تلبية احتياجات البلاد المتزايدة من الورق، والارتقاء بهذه الصناعة الحيوية إلى أرقى المستويات، وذلك من مختلف أنواع الورق الثقافي والصناعي.. وأهمها

الورق الثقافي

ورق الطباعة • ورق الكتابة • كربون الطبع المقوى
ورق الرسم النظري المانيفولد • ورق خطابات البريد الجوي
ورق الكربون • السجلات • المجلات

الورق الصناعي

الذي يستعمل في تغليف الغزل والمنسوجات وفي صناعة الصناديق، وأقماع الغزل ومواسير الغزل، وعلب السجائر، والكبريت، ولف المنتجات الصناعية والزراعية، وأغلفة الكتب والكراريس المدرسية، وورق الزبدة، أوراق التواليت الأوالية والبوستر، والسلفيت، والكرافت، والمانيلا

أكثر من ٩٥ عاماً في خدمة الاقتصاد القومي

أولى شركات صناعة الورق بجمهورية مصر

الإدارة: الطابية - خط رشيد تليفون: ٦١٢٣٠
المصانع: {الطابية - خط رشيد " ٦١٢٣٠
{محرم بك - قنال المحمودية ت: ٢١٣٠٢ - ٢١٣٠٣ - ٢١٣٠٤

المكاتب:
الإسكندرية: ٤٤ شارع سعد زغلول ت: ٢٢٩٢٢ - ٣٠٧٣٨
القاهرة: ١٩ شارع عدلي تليفون: ٥٢٦٢٤

شركة الوادي الجديد العامة للمقاولات

إحدى شركات المؤسسة المصرية العامة لمقاولات المباني

المركز الرئيسي: ١٥ أ. شارع عماد الدين بالقاهرة ت: ٩١٧٥٩٩

من أولى الشركات التي قامت بتنفيذ العديد من المشروعات الكبرى من

إسكان | مصانع | دور علم
دور عبادة | خدمات
أعمال المجهود الحربي | مشروعات إنتاجية

والشركة في سبيل تطوير أسلوب العمل انطلاقاً من روح أكتوبر العظيم تحت قيادة الرئيس المؤمن

محمد أنور السادات

الهيئة العامة لتعاونيات البناء والإسكان

تقوم الهيئة بالمسئوليات الآتية:

- تنمية الاقتصاد القومي في مجال البناء والإسكان التعاوني وفقاً للسياسة العامة للدولة.
- الإشراف على ما يتبعها من الجمعيات التعاونية للبناء والإسكان، والجمعيات التعاونية للإنشاء والتعمير بما يكفل لها تحقيق الأهداف والبعد عن الاستغلال.
- نشر الوعي التعاوني لتحقيق الأهداف الاشتراكية التعاونية في مجال الإسكان والبناء وتعمل الهيئة على خفض تكاليف المساكن بكل الوسائل التي من أهمها:

أ. وضع تصميمات خاصة وفق حاجة مختلف المستويات وأهمها الإسكان الشعبي والمتوسط.
ب. تيسير الحصول على مواد البناء.
جـ. إعطاء القروض اللازمة لأعضاء الجمعيات التعاونية لاستكمال البناء.
د. خفض تكاليف البناء نتيجة للجهود الذاتية بالإضافة إلى تجميع المدخرات في شكل مبالغ تسهم في زيادة الثروة القومية وتقلل الإنفاق على المواد الاستهلاكية



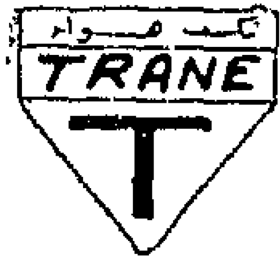
شركة النيل العامة للمصاعد

احدى شركات المؤسسة المصرية العامة للإسكان والتعمير

قطاع المصاعد  شندلر

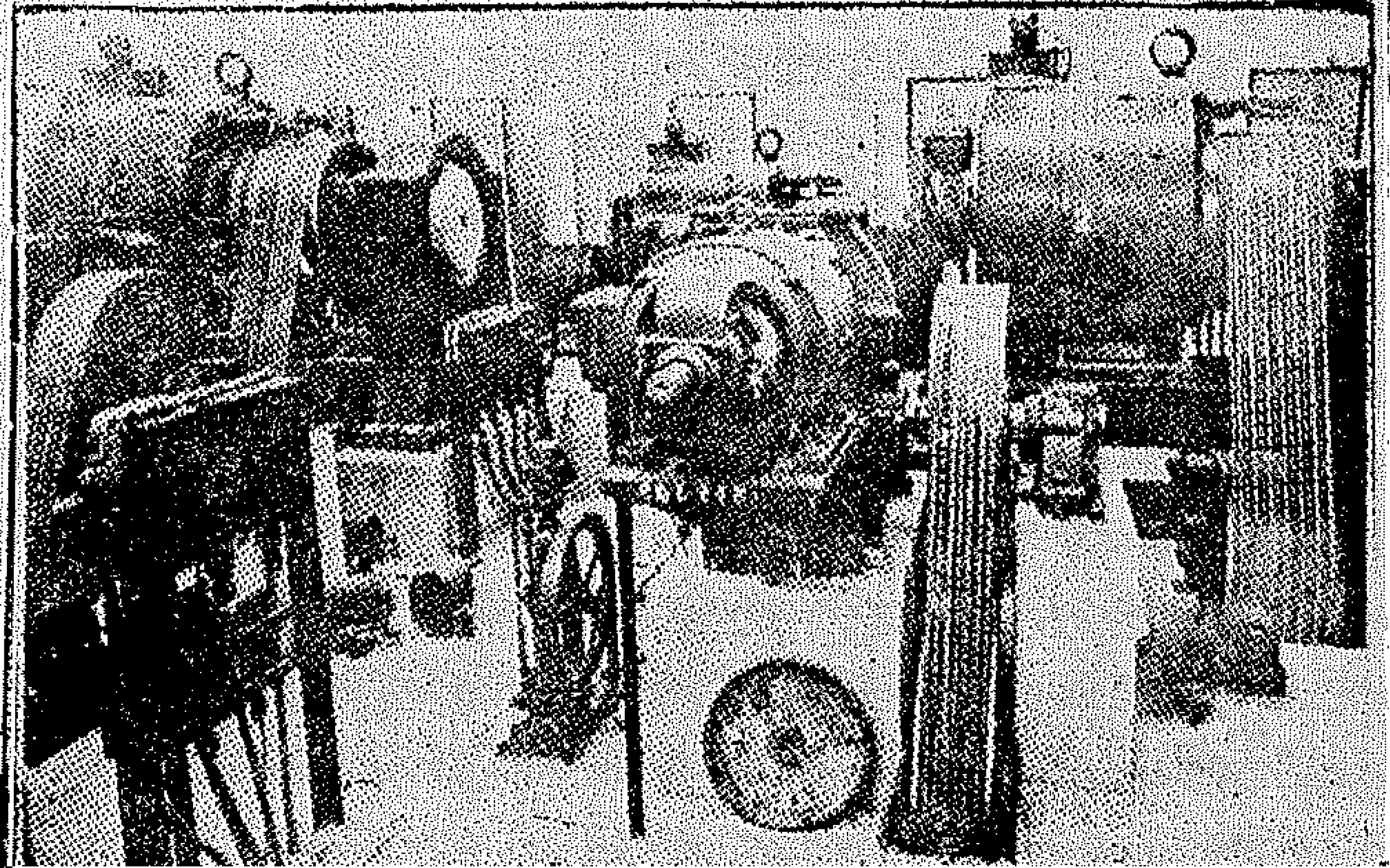
تركيب المصاعد وصيانتها بالفنادق الكبرى والمستشفيات والمصانع والمباني العامة والمساكن ودور العلم والثقافة وفقاً لأحدث المواصفات العالمية ... كما تم توقيع عقد إقامة مصنع متكامل لمصاعد « شندلر » مع التصريح باستخدام علامته التجارية ، وتصل طاقة المصنع في الوردية الواحدة ٥٠٠ مصعد سنوياً .. يصدر الفائض منها عن الإستهلاك المحلي .. إلى الدول العربية والأفريقية

تكييف الهواء « ترين »



توريد وتركيب وصيانة واصلاح أجهزة التكييف المركزية بالمنشآت العامة والصناعية لخدمة السياحة والنشاط العلمي والطبي وصناعة الغزل والنسيج الى جانب المنشآت العسكرية بأحدث الأجهزة الميكانيكية والكهربائية لتوفير الجو المناسب باستمرار

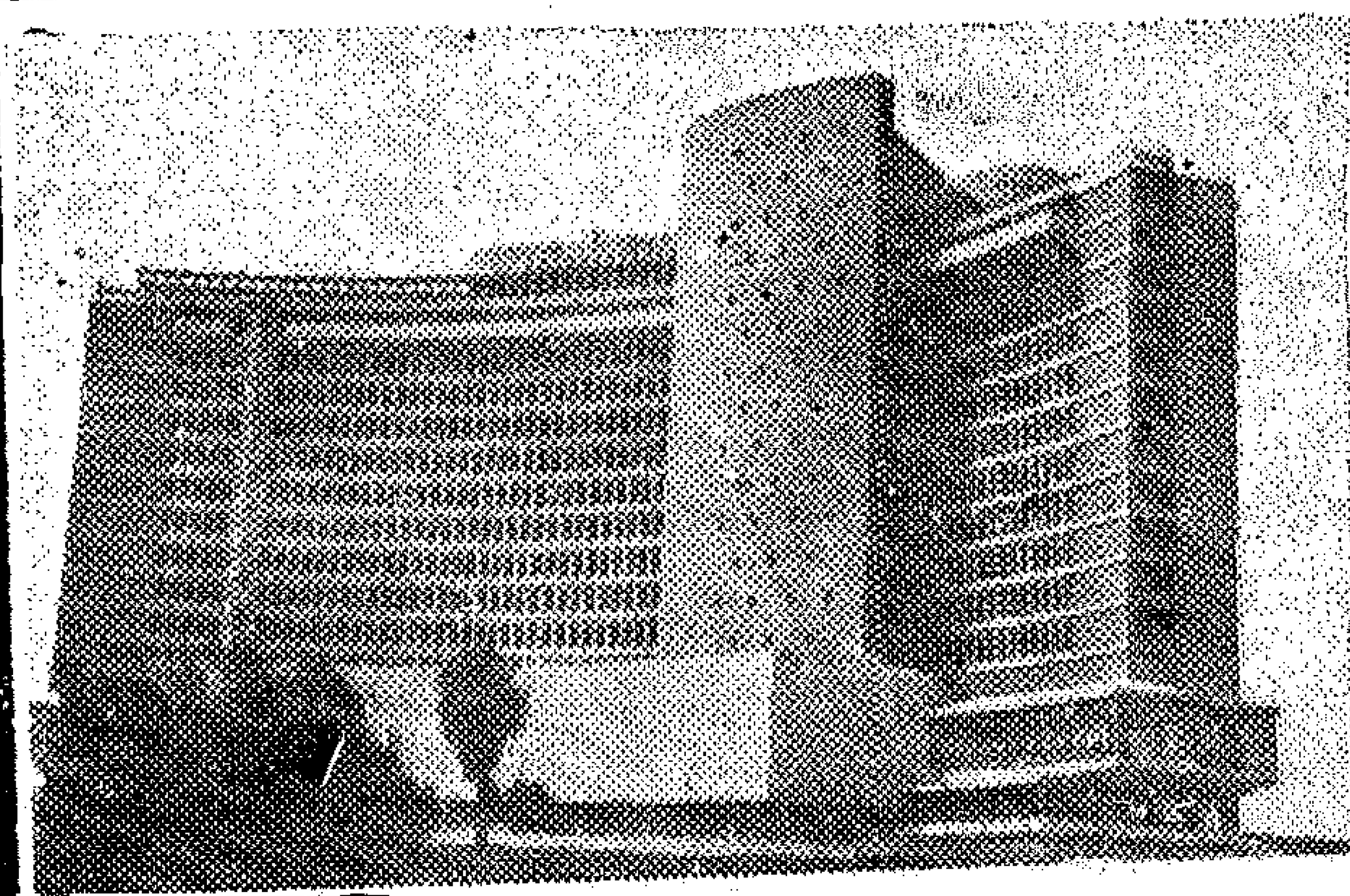


جزء من حجرة ماكينات المصاعد التي قامت بتركيبها شندلر بالقاهرة في فندق شيراتون بالقاهرة

الإدارة العامة
القاهرة : ٢٣ شارع طلعت حرب ت { ٧٩٥٣٣ ٤٥٥١٤

فندق « مريديان »

« على النيل - جاردن سيتي »



أحدث فنادق القاهرة

تنفيذ

الشركة العامة للانشاءات

احدى شركات المؤسسة المصرية العامة لمقاولات الإنشاءات المدنية

المؤسسة المصرية العامة لمقاولات الانشاءات المدنية وشركاتها

ودورها الكبير بعد النصر

لم تقم حرب العاشر من رمضان من أجل عبور القناة ، وتحطيم خط بارليف وهزيمة العدو ، وتحرير الأرض ... بل قامت أساسا لتحرير الانسان العربي ووضعه أمام مسئولياته ، ومقدراته تلك هى حرب العاشر من رمضان ... كانت التحدى الحقيقى ليثبت الإنسان العربى وجوده بتلك الوقفة الشجاعة المصممة التى أذهلت العالم . وكان لابد أن يتجاوز الانسان العربى ... تلك المرحلة الى مراحل أخرى ، أبدع وأعظم أن يعمل على تنمية مواردة واستغلال طاقاته . فى جميع قطاعاته المختلفة ... وفى مقدمتها قطاع التشييد والبناء ... الذى يعتبر الواجهة المضيئة خلال كفاح الجماهير من أجل خلق غد مشرق .. ففى كل مكان .. وعلى امتداد أرضنا الطيبة .. يقف قطاع التشييد والبناء ... شامخا عظيما .. واذا كنا نقول هذا الكلام عن هذا القطاع .. فان **المؤسسة المصرية العامة لمقاولات الانشاءات المدنية** تتصدر هذا القطاع .. بنشاطها الضخم الذى يمتد باذرعها المنتشرة لتبنى الغد المشرق فى وادينا الطيب .. ان **المؤسسة المصرية العامة لمقاولات الانشاءات المدنية** تلقى بكل طاقتها الجبارة من خلال ١١ شركة .. ليظهر العمران والخير فى كل مكان واذا كان السد العالى أحد تحدياتنا الضخمة فى وجه الامبريالية العالمية .. فان **المؤسسة المصرية العامة لمقاولات الانشاءات المدنية** وشركاتها الـ ١١ ... هى جيشنا القوى فى هذا التحدى .. ان هذه الشركات هى التى وقفت كالمارد .. تصد التحدى .. حتى حطمته .. وأثبتت بما لا يدع مجالاً للشك أو للمناقشة قدرة العامل المصرى ... والعقلية المصرية ...

ان شركات المقاولات عندنا مقبلة على أسمى وأقدس مهمة وهى اعادة وتعمير مدن القناة الثلاث .. لتواصل مسيرة الحياة .. ان جيش المهندسين والفنيين والعمال .. ينتظر بكل الخبرة والامكانيات والحب والاخلاص والجهد والعزيمة لبناء حياة جديدة باسمة فيها كل أسباب الحياة العصرية من مساكن حديثة ومدارس ومرافق ومستشفيات ومصانع ودور العبادة .. وسيتم ذلك فى وقت سريع وعلى أرقى المستويات وذلك بما لديها من امكانيات وخبرات .

وهناك حقيقة لا يمكن تجاهلها وهى أن الدول النامية الحديثة الاستقلال أمامها أن تحافظ على هذا الاستقلال عن طريق استثمار جزء من ميزانيتها فى المشروعات العمرانية التى تضاعف من دخلها القومى وتمنع رؤس الأموال الأجنبية من انتهاز فرصة الحصول على مكاسب طائلة .. ولعل لغة الأرقام هى أصدق دليل على ما استطعنا تحقيقه فى طريقنا لانجاز الهدف الكبير فى مجال البناء والانشاءات فقد نجحت جمهورية مصر العربية فى تنفيذ مشروعات انشائية بلغت تكاليفها ما يقرب من ٧٥٠ مليون جنيه فى الخطة الخمسية الأولى رغم أن ما كان ينفذ من مشروعات قبل

عام ١٩٦١ (أى قبل التـأمين) ، لم يتعـد ٣٠ مليون جنيه سـنويا وقد بلغت الاسـتثمارات فى المبـانى ولتشـييدات خـلال الخطتين الأولى والثانيـة (أى من عام ٦٠ الى ٧٠) .

* ٣٩٣ مليون جنيه فى قطاع الصناعة .
* ٤٠١ مليون جنيه فى قطاع الاسكان والمرافق .
* ١٨٠ مليون جنيه فى قطاع النقل والمواصلات والتخزين وقناة السويس .
* ١١٧٠ مليون جنيه فى انشاءات السد العالى .
* ١٣٣ مليون جنيه فى قطاع الخدمات .

وبذلك تكون جملة الاستثمارات قد وصلت خـلال هـذه الفترة الى ٢٢٧٧ مليون جنيه .

وقد قام بتنفيذ المشروعات شركات المقاولات المصرية التى استطاعت بعد التأميم ان تزيد من امكانياتها الفنية والمالية وأن تنجح فى تحقيق الدور الحيوى الذى قامت من اجله فنفذت المشروعات الصناعية والبترولية والزراعية والعمرانيـة والبحرية والسياحيـة يسـاعدها فى ذلك توفير الامكانيـات المحليـة التى أتاحت تنفيذ هذه المشروعات على أكمل وجه سنواء من حيث الآلات والمعدات والطاقات البشرية المدربة والخبرات الفنيـة ويرى **المهندس جمـال الدين عبـد الرحمن** رئيس مجلس ادارة المؤسسة ان من أهم الأسباب التى ساعدت شركات المقاولات المصرية على تحقيق هذا النجاح الكبير هو ضمان الحكومة لها وانشاء مؤسسة متخصصة تجمع هذه الشركات وتتولى تدعيمها بكافة الامكانيات الفنية والمادية التى تمكنهـا من التصدى لأضخم المشروعات فى مختلف القطاعات فى الداخل والخارج .

ان شركات المقاولات المصرية قد برزت فى ستة ميادين ، حققت فيها كل التفوق والنجاح . وهى أعمال المواسير والمنشآت الصناعية ، والاسكان والمبانى العامة ومد الشبكات الكهربائية والحفر على الناشف .

ولقد قامت بعض الشركات الى جانب ذلك بجهد كبير فى العديد من المشروعات على المستوى العربى والافريقى .

وهناك مشروعات كثيرة فى مختلف أنحاء الوطن العربى والافريقى تشهد بقـدرة الشركات المصرية وكفاءتها بما يتيح لهـا أن تقف على مستوى المنافسـة مع أكبر الشركات العالمية فى هذا الميدان وتلازم هذه الشركات كل مشروعات البناء والتعمير فى انحاء البلاد العربية ـ ففى ليبيـا قامت بعض شركات المؤسسة ببناء مساكن جديدة بمحافظتى طرابلس وبنغـازى الى جانب بعض المشروعات الانشائيـة الأخرى وفى السعودية قامت بتنفيذ مشروعات الميـاه والكهرباء والطرق على أرقى المستويات العالميـة . وفى السـودان تولت مهمة انشاء محطات الميـاه والخزانات على امتداد محافظات السودان لتكون فى خدمـة التطور والتقدم ، وكذلك بالنسـبة لمشروعات الكهرباء من خزان الروصيرص .

وفى الجزائر تم انشاء ما يزيد على ألف مسكن بمنطقة أرزو البتروليـة وكذلك معظم الانشاءات الحيوية بمجمع الحديد والصلب .

وفى الكويت تولت مسئولية اقامة المدارس والمستشفيات وبنـاء المبانى العـامة والقصور ومبنى الجهاز المركزى للمواصلات السلكية واللاسلكية ، واستطاعت بذلك أن تضمن وضع اسمها فى قائمة الشركات العالمية التى تقوم بتنفيـذ مشروعات دولة الكويت .

وبهذا يمكن أن نقول أن بصمات هذه الشركات أصبحت واضحة الآن في انطلاقة الحياة الجديدة فوق الرقعة العربية والافريقية .. وهى تنظر الى هذا الدور العربى بنفس الأهمية التى تنظر بها الى دورها فى البناء الداخلى ، ايمانا منهـــا بأن مضير الوطن العربى واحد وأن كل خطوة تقدم فوق أى بقعة منه محسوبة لصالح التقدم العربى كله .

ولهذا فان **المؤسسة المصرية العـامة لمقـاولات الانشاءات المدنية** لا تقف عند حد العمل داخل بلادنا ، فانها تتعداها الى خارج الحدود لتؤكد وتؤهل اتصال الثـورة المصرية بالأرض العربية والأرض الافريقية . ونتيجة هذه الجهود ، هى تلك الأعمال الهائلة التى حققتها المؤسسة والتى بلغت قيمتها ٦١ مليون و ٥٠٠ ألف جنيه ، منها ١٨ مليون جنيه و ٥٠٠ الف جنيه خارج الجمهورية .

وتتحرك **المؤسسة المصرية العامة لمقـاولات الانشاءات المـدنية** . داخل نشاطها الكبير عن طريق شركاتها التى تنتشر على أنحاء أرضنا داخل مصر ، وداخل البـــلاد العربية والافريقيـــة . هــذه الشركات التى تعطى كل جهودها من أجل خلق ظروف أفضل للمواطن العربى والافريقى . وهذه الشركات هى : ــ

١ ــ الشركة العامة للانشاءات (رولان) .

٢ ــ شركة النصر للمبانى والانشاءات (ايجيكو نصر) .

٣ ــ شركة المقاولات المصرية (مختار ابراهيم) .

٤ ــ شركة المشروعات الصناعية والهندسية .

٥ ــ الشركة المساهمة المصرية للمقاولات (العبد) .

٦ ــ شركة النيل العامة للمقاولات .

٧ ــ شركة النيل العامة للكبارى .

٨ ــ شركة النصر للأعمال المدنية .

٩ ــ الشركة العربية للأعمال المدنية .

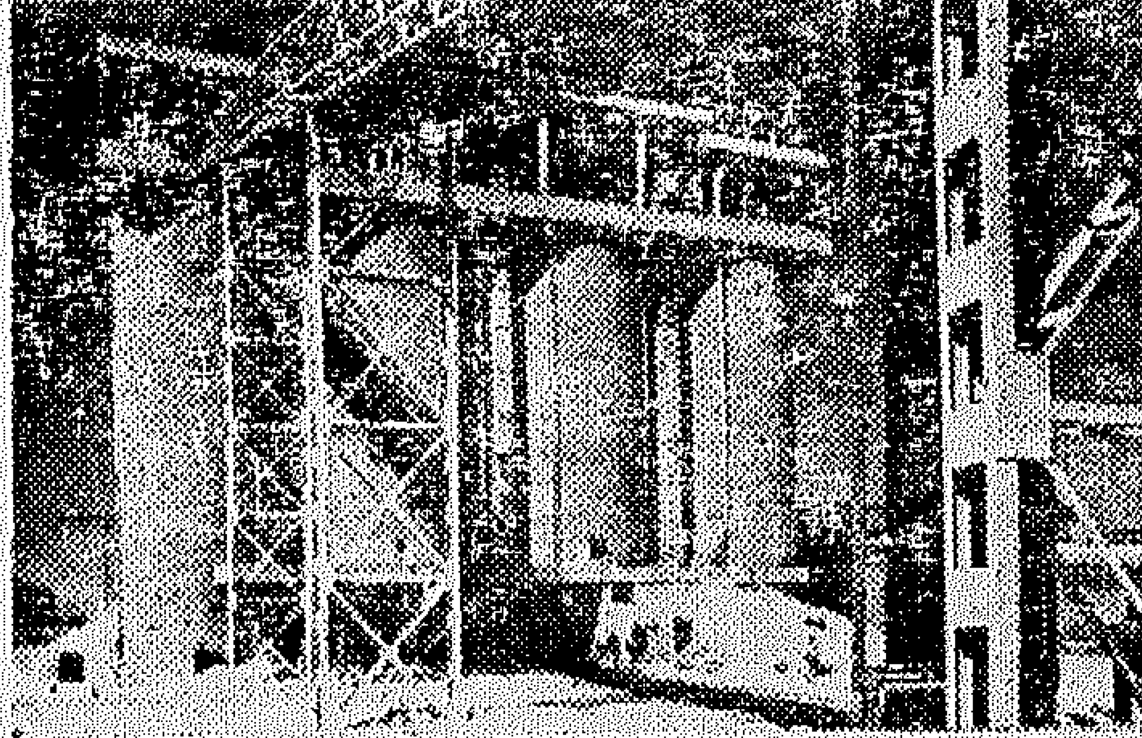
١٠ ــ الشركة العربية للأساسات .

١١ ــ شركة النصر للمرافق والتركيبات .

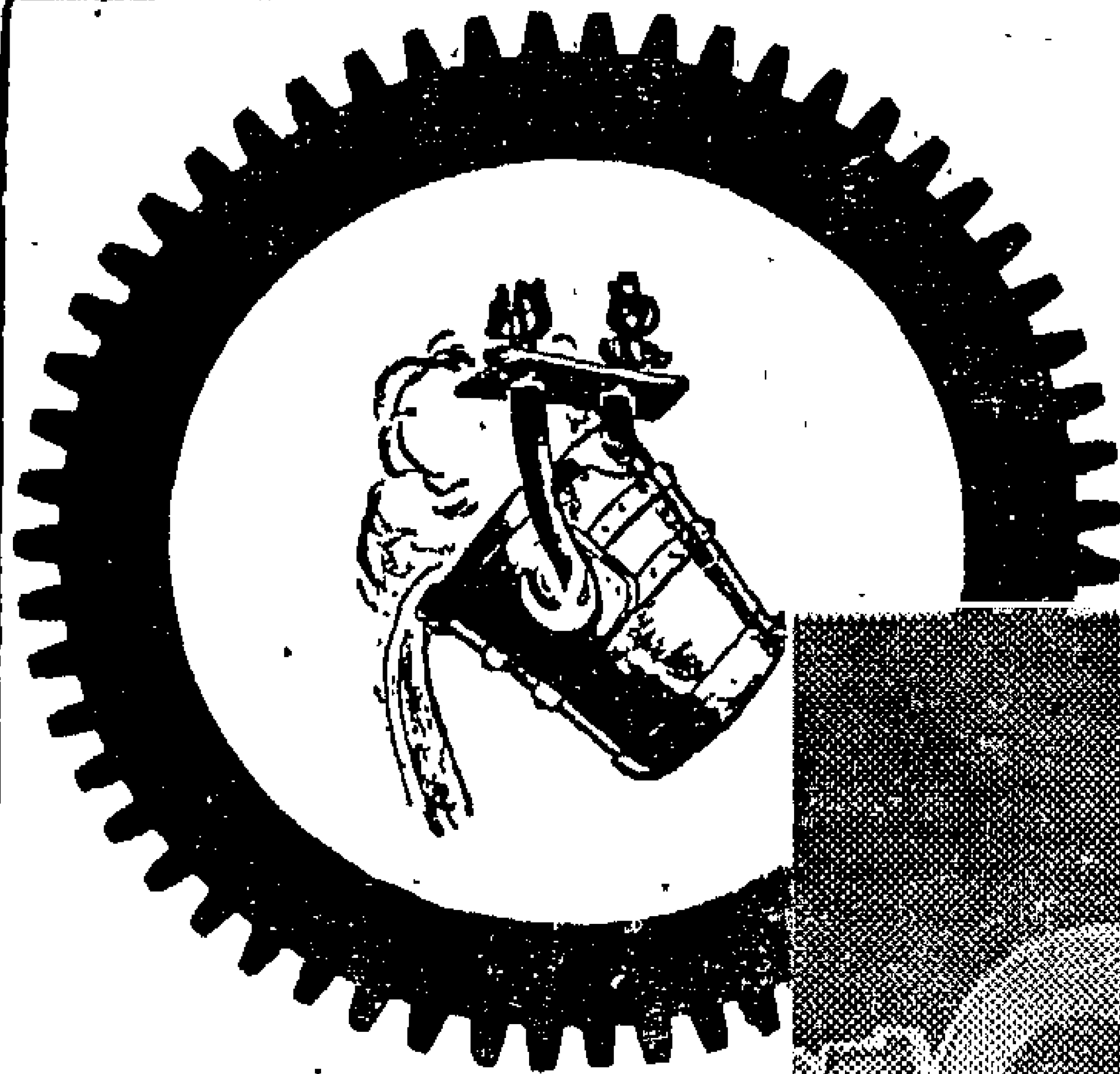
داخل هذه الخطوط والضوابط التى قدمناها يستمر العمل ، نشيطا ، واعيـا داخل **المؤسسة المصرية العامة لمقاولات الانشاءات المدنية** وشركاتها .

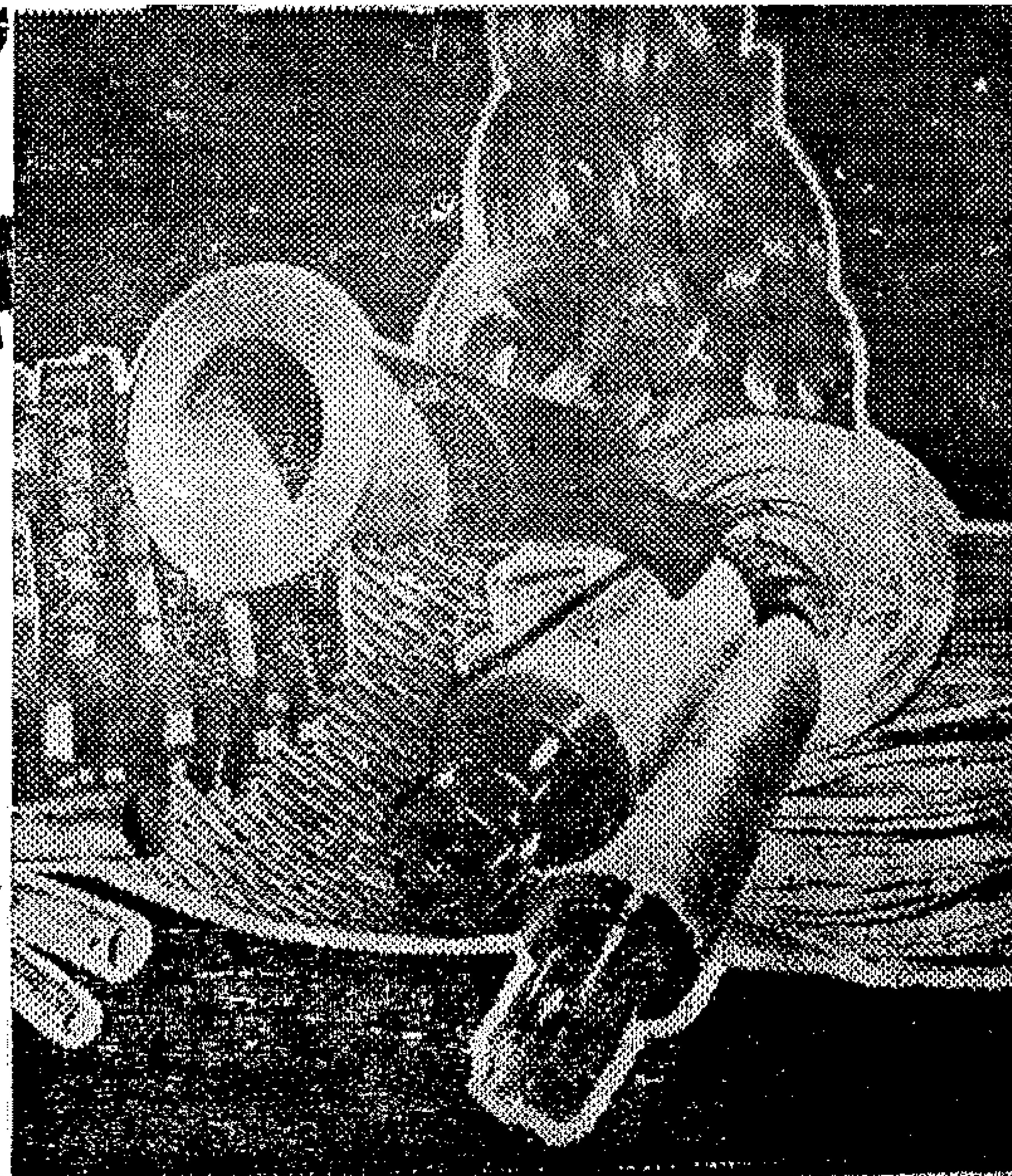
وانطلاقا من تلك الأسس تدخل المؤسسة وشركاتها ، مرحلة الانفتـــاح والتعمير الذى تدخله بلادنا بعد حرب العـــاشر من رمضـــان المجيـــد ، واذا كانت المؤسسة وشركاتها قد قدمت الكثير من أجل معركة الشرف والكرامة ومن أجل النصر فانهـا بعد تحقيق النصر ، تدخل مرحلة جديدة ومؤثرة تحتاج كل الجهد .. والنشاط .. والخبرة . وهى بقيـــادتها الواعية الرشـــيدة ، التى يرأسها **المهنـدس جمــال الدين عبـد الرحمن** رئيس مجلس ادارة المؤسسة تدخل عصر العطاء والبـذل ، قادرة على الوفاء بكل آمال الجماهير .. وأحلامها .. وهى بذلك تدخل مرحلة النشاط الكبير . فأمامها اعادة الحياة الى ثلاث محافظـــات عزيزة وغاليـــة على قلب كل مصرى هى محافظات القنـــاة حاملة عبء اعادة ما قد توقف ... بل أفضل مما كان . أن النصر الذى حققته قواتنا المسلحة الباسلة ، قد فتح الطـريق أمام بلادنا ، لتدخل عصر التكنولوجيا الحديثة ولتأخذ مكانها تحت الشمس ، بقيـــادة **الزعيم البطل والرئيس المؤمن محمد أنور السادات** بطل النصر وقائد ما بعد النصر ، الذى سيكتب له التاريخ **انه رد الى جماهير أمتنا العربية كرامتها وعزتها لتحقيق مصر المستقبل .**





الصوامع - مصنع الطوب الرملى بمدينة نصر





التصنيع والانتاج

جمعية المهندسين الكهربائيين
والالكترونيين
جمعية الهندسة الادارية
جمعية المهندسين الميكانيكيين

Thus, the solution of the transient stability problem is obtained by simple graphical constructions.

It is hoped that the graphical method outlined in this paper with its applications and the results obtained will justify the use of this new approach for the solution of transient stability problems of power systems that can be reduced to two equivalent machines.

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1. Draw the vertical straight line $\delta = \delta_o$ to cut the curve representing the function $\psi(\delta)$ for $K_2 = 0$ at the point f_1.

2. Draw the straight line (1) with slope K_1 and passing through the point f_1 to cut the vertical straight line of $\delta = 60°$ at point a. The kinetic energy of the machine may be determined from Figure 4. to be equivalent to the length ab.

$$\therefore ab = \frac{1}{2}\left(\frac{d\delta}{dT}\right)^2 = \frac{1}{2} \cdot \frac{M}{P_1}\left(\frac{d\,\delta}{d\,t}\right)^2$$

3. Specify a point c on line ab such that

$$bc = \frac{1}{2}\left(\frac{d\,\delta}{d\,T'}\right)^2 = \frac{1}{2} \cdot \frac{M}{P'_1}\left(\frac{d\delta}{d\,t}\right)^2$$

$$\therefore \frac{bc}{ab} = \frac{P_1}{P'_1} = \frac{0.42}{1.25} = 0.336$$

4. Draw a straight line with slope K_1' and passing through the point c. This straight line, as shown in Figure 4., does not cut the curve representing the function $\psi(\delta)$ and, therefore, indicating that the kinetic energy cannot reach zero i.e. the stability will be lost. Hence, the clearing angle $\delta = 60°$ is greater than the critical value.

In order to determine the critical clearing angle, a straight line (2) with slope K'_1 is drawn tangential to the curve $\psi(\delta)$ as shown in Figure 4. The operating point will move on this line for the critical post-fault conditions.

The vertical straight line at $\delta = \delta_c$, where δ_c is the critical clearing angle, cuts the two lines (1) and (2) at the points a_1 and c_1 respectively, such that

$$\frac{b_1c_1}{a_1b_1} = \frac{P_1}{P'_1} = 0.336$$

The figure shows that the angle $\delta = 52°$ fulfills this condition i.e. $\delta_c = 52°$.
$\therefore$ the critical clearing angle = 52°.

In order to check the accuracy of solution by this new graphical method, the equal-area criterion is applied in Figure 4. Application of the formula

$$\cos\delta_c = \frac{P_o(\delta_o - \delta m) + P_1 \cos\delta_o - P'_1 \cos\delta m}{P_1 - P'_1}$$

gives the value $\delta_c = 51.6°$ which agrees to a sufficiently high degree of accuracy with the result obtained by the application of the new graphical method.

It is to be noted that the effect of transient saliency of synchronous machines can be taken into account by selecting the suitable curve representing the function $\psi(\delta)$ for the specified value of K_2.

Conclusions

The new graphical method forwarded in this paper is a simple and feasible method for the solution of transient stability problems of synchronous two-machine power systems. The method is capable of taking into account the effect of transient saliency of synchronous machines that is frequently a decisive factor in stability studies. Tedious numerical computations are entirely eliminated by the application of this new method which is relatively easy to use and is accurate. Accuracy of solution by this new method has been checked by comparison with other methods.

Moreover, the new graphical method has the advantage that the fault condition is represented on the chart by a straight line instead of a sine curve as in the equal-area criterion or by a curved trajectory as in the phase-plane technique.

Solution

The system parameters are calculated as follows :

During the fault :

$$K_1 = \frac{P_o}{P_1} = \frac{1}{0.42} = 2.381, \quad K_2 = 0$$

$$T = t\sqrt{\frac{P_1}{M}} = t\sqrt{\frac{0\cdot 42}{M}} = \frac{0.648t}{\sqrt{M}}$$

After the fault :

$$K'_1 = \frac{P_o}{P'_1} = \frac{1}{1.25} = 0.8, \quad K'_2 = 0$$

$$T' = t\sqrt{\frac{P'_1}{M}} = t\sqrt{\frac{1\cdot 25}{M}} = \frac{1.118t}{\sqrt{M}}$$

The initial angle δ_o is given by

$$\sin \delta_o = \frac{P_o}{P_1} = \frac{1}{1\cdot 735} = 0.57637$$

$$\therefore \delta_o = 35\cdot 2^\circ$$

The procedure for applying the new graphical method is illustrated in **Figure 4.** and consists mainly of the following steps:

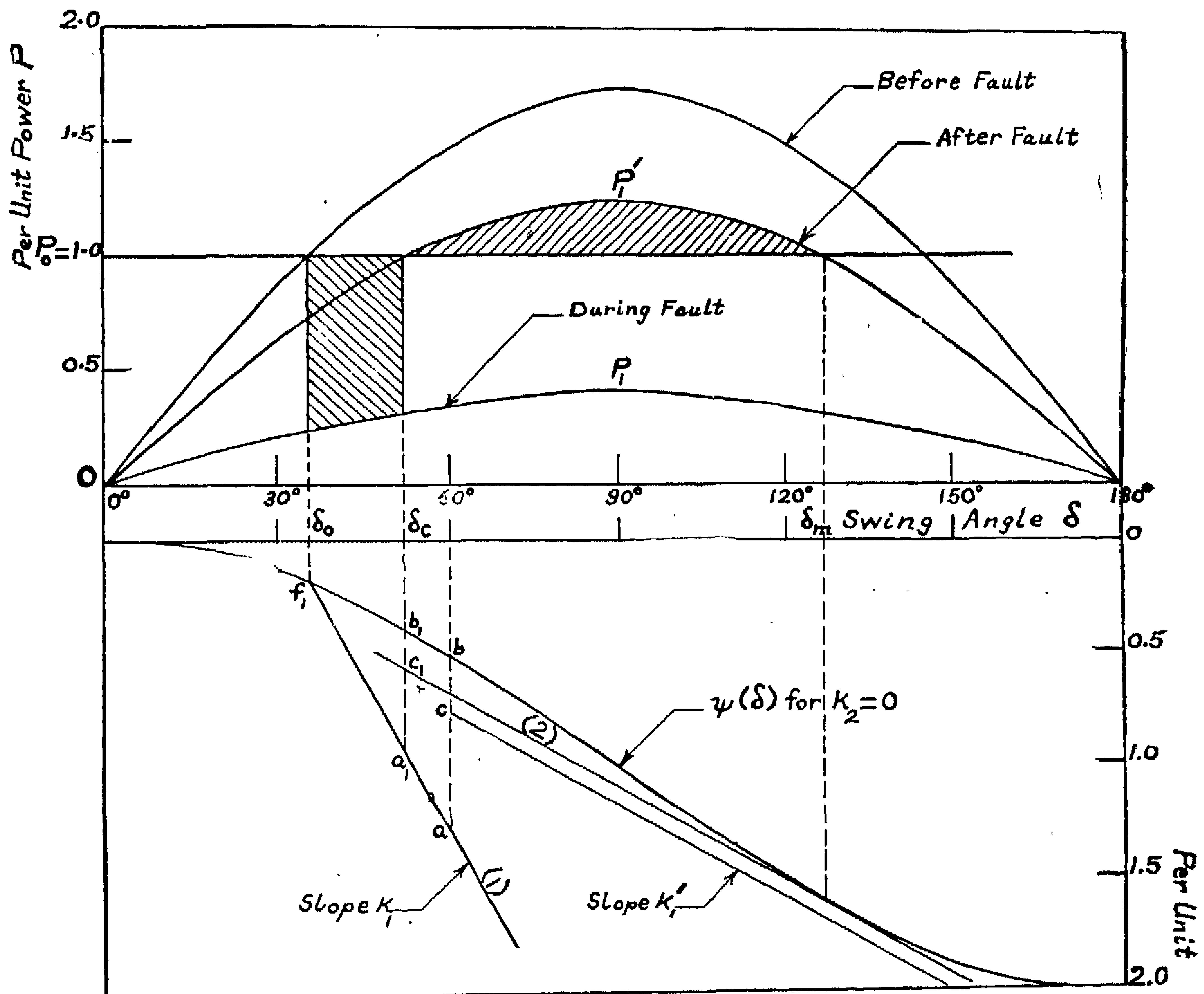


Figure 4. Checking the Stability and Estimation of the Critical Clearing Angle.

kinetic energy $\frac{1}{2}\left(\frac{d\delta}{dT}\right)^2$ as a function of the swing angle δ .

Applications of the New Graphical Method

(i) Estimation of the range of oscillations and the final steady-state operating angle

Figure 2. shows the range of oscillations of a synchronous machine subjected to a disturbance characterised by the initial conditions δ_o, $\left(\frac{d\delta}{dT}\right)^2_{at\,\delta=\delta_o} = 2\ m_1 n_1$, and certain values for the parameters K_1 and K_2.

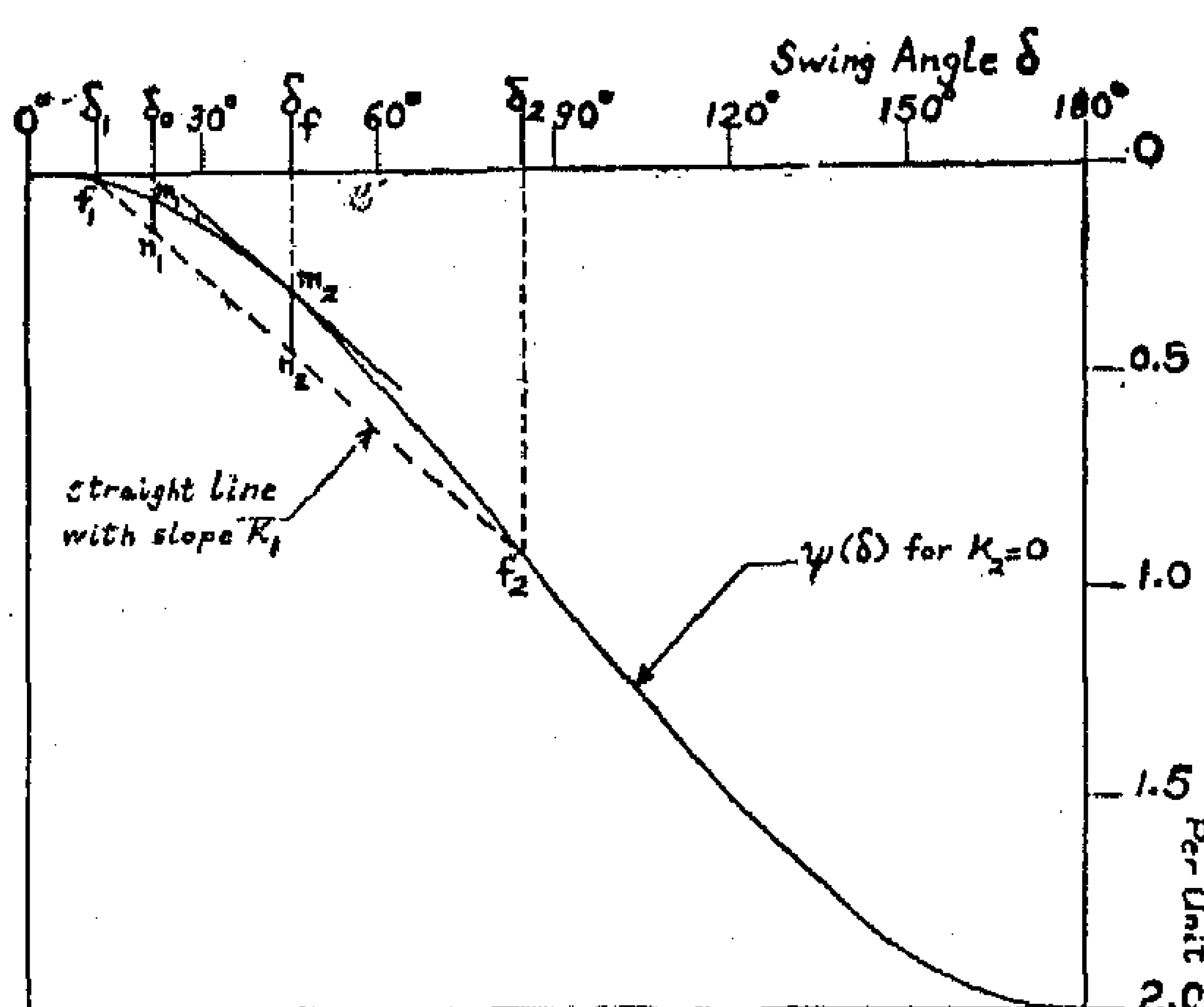


Figure 2. Estimation of the Range of Oscillations and the Final Steady-State Angle on the Kinetic Energy Chart.

According to Figure 2., the machine swing angle will oscillate between δ_1 and δ_2. The oscillations will decrease due to damping and the final steady-state angle δ_f will be reached.

The operating point starts from the initial point n_1 and then moves on the dotted line f_1 f_2 until the kinetic energy becomes zero i.e. at the point f_1 or at f_2 The operating point moves in the direction of f_1 if $\left(\frac{d\delta}{dT}\right)_{at\,\delta=\delta_o} < 0$, or in the direction of f_2 if $\left(\frac{d\delta}{dT}\right)_{at\,\delta=\delta_o} > 0$.

The range of oscillations is defined on Figure 2. as the range at which the kinetic energy is positive.

The final steady-state operating point can be obtained by drawing a straight line parallel to the line $f_1 f_2$ and tangential to the curve $\psi(\delta)$ .Hence, the point of maximum kinetic energy $m_2\ n_2$ can be determined. Thus, the final steady-state angle δ_f is found as shown in Figure 2.

(ii) Checking the stability and estimation of the critical clearing angle

In order to illustrate the application of the new graphical method for checking the stability and estimating the critical clearing angle, consider the example of the sample power system shown in Figure 3. in which a generator feeds power to an infinite bus through two parallel high voltage transmission lines. Numbers on the diagram indicate the values of the reactances in per unit. The transient reactance of the generator is included in the values marked. Circuit breakers adjacent to a fault on both sides are arranged to clear simultaneously.

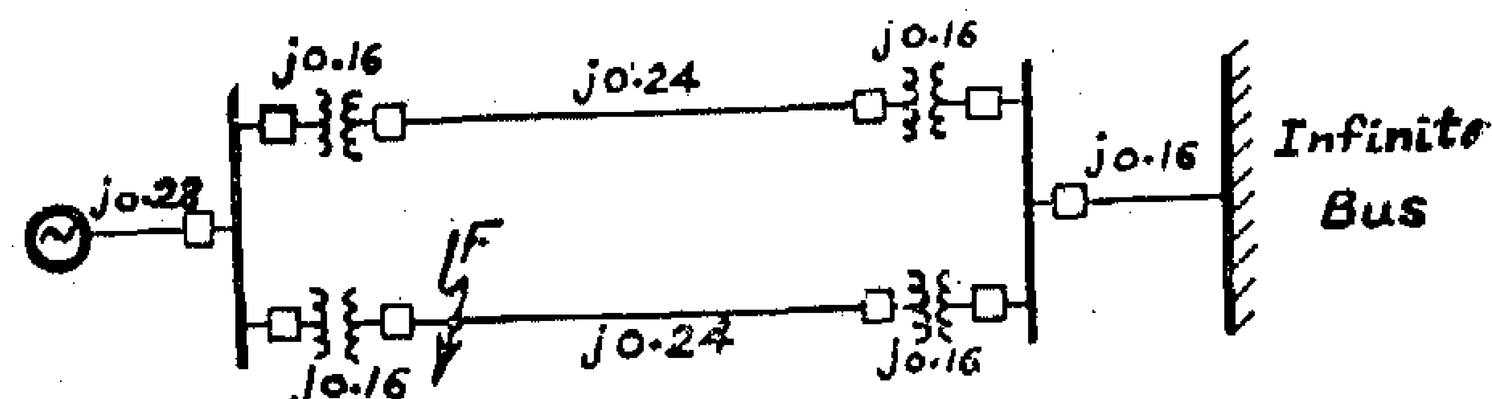


Figure 3. Single-Line Diagram for Sample Power System.

It is required to check the system stability for a clearing angle of 60°, and to estimate the critical clearing angle for the generator in the case of a three-phase fault at the point F when the generator is delivering 1.0 per unit power. Assume that the voltage behind transient reactance is 1.25 per unit for the generator and that the voltage at the infinite bus is 1.0 per unit.

Equations for the power output of the generator are

Before the fault: $P = 1.735 \sin \delta$
During the fault : $P = 0.42 \sin \delta$
After the fault : $P = 1.25 \sin \delta$

ing constant flux linkages, then the swing equation of the synchronous machine is given by

$$M\,\frac{d^2\delta}{dt^2} = P_o - P_e - P_d$$

where M = inertia constant

δ = angle of swing from reference axis

t = time

P_o = power input

$P_e = P_I \sin\delta - P_2 \sin 2\delta$ = power output, and $(P_2 \sin 2\delta)$ represents the effect of transient saliency of the synchronous machine.

$P_d = K_d\,\frac{d\delta}{dt}$ = power absorbed in damping, and K_d is the damping coefficient.

Let $T = t\sqrt{\frac{P_I}{M}}$, $a = \frac{K_d}{\sqrt{P_I . M}}$,

$K_I = \frac{P_o}{P_I}$, and $K_2 = \frac{P_2}{P_I}$.

Then, the swing equation becomes

$$\frac{d^2\delta}{dT^2} + a\,\frac{d\delta}{dT} = K_I - \sin\delta + K_2 \sin 2\delta$$

Multiplying both sides of the above equation by $\frac{d\delta}{dT}$, integrating with respect to T, and neglecting damping

$$\therefore \left[\tfrac{1}{2}\left(\frac{d\delta}{dT}\right)^2\right]_{\delta_o}^{\delta} = \int_{\delta_o}^{\delta} (K_I - \sin\delta + K_2 \sin 2\delta)\, d\delta$$

$$\therefore \tfrac{1}{2}\left(\frac{d\delta}{dT}\right)^2 = \tfrac{1}{2}\left(\frac{d\delta}{dT}\right)^2_{\text{at } \delta=\delta_o} + K_I(\delta - \delta_o) + \cos\delta - \cos\delta_o - \frac{K_2}{2}(\cos 2\delta - \cos 2\delta_o)$$

Introducing a function

$$\psi(\delta) = 1 - \cos\delta - \frac{K_2}{2}(1 - \cos 2\delta),$$

the above equation reduces to

$$\tfrac{1}{2}\left(\frac{d\delta}{dT}\right)^2 = \tfrac{1}{2}\left(\frac{d\delta}{dT}\right)^2_{\text{at}\,\delta=\delta_o} + K_I(\delta - \delta_o) - [\psi(\delta) - \psi(\delta_o)]$$

Considering now a synchronous machine subjected to a disturbance characterised by the initial conditions δ_o, $\left(\frac{d\delta}{dT}\right)_{\text{at}\,\delta=\delta_o}$, and certain values for the parameters K_I and K_2. The chart shown in Figure 1. gives the values of $\frac{1}{2}\left(\frac{d\delta}{dT}\right)^2$ as a function of the swing angle δ. Consequently, this chart may be called "the kinetic energy chart".

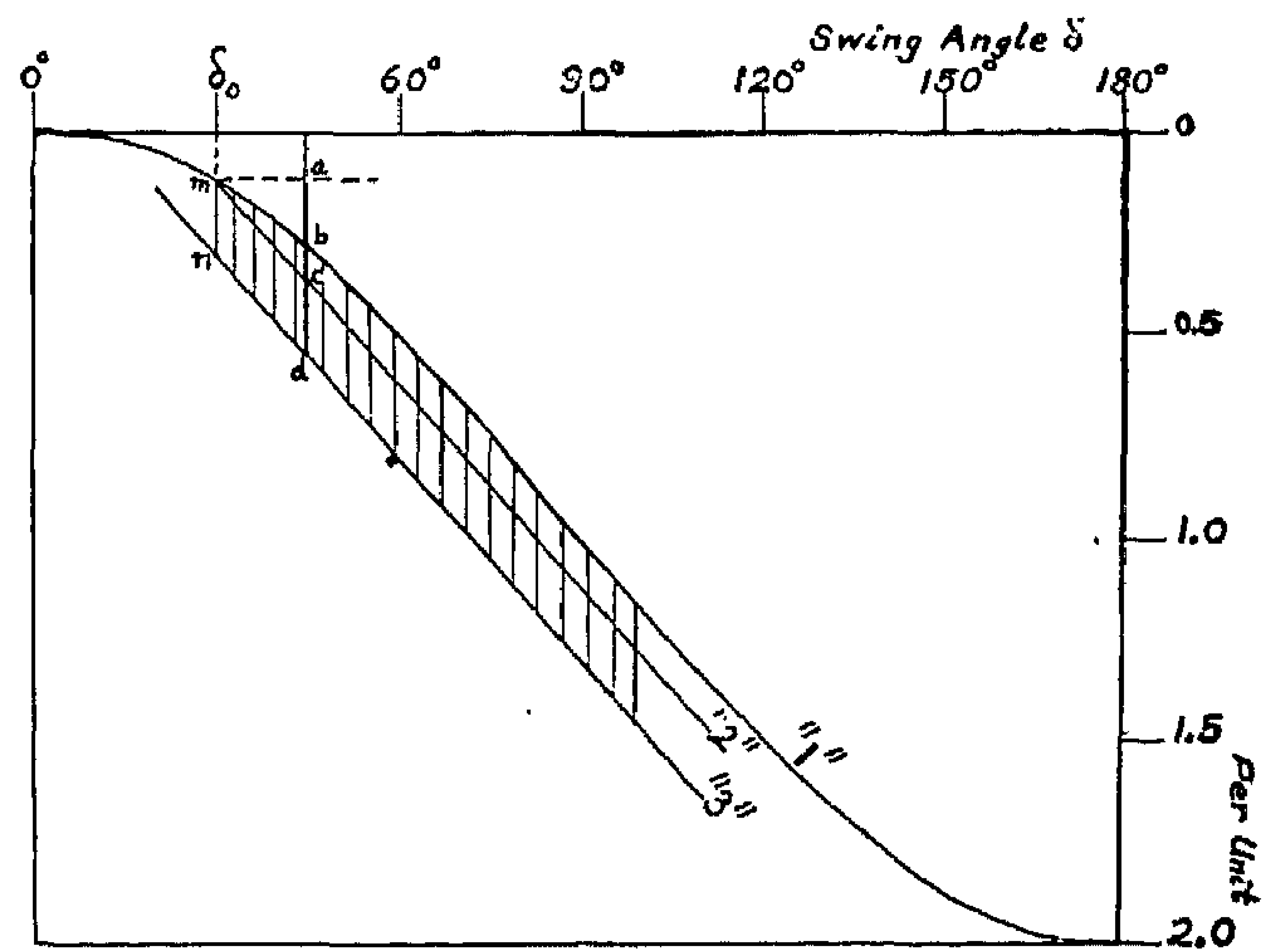


Figure 1. The Kinetic Energy Chart.
"1" represents $\psi(\delta)$ for $K_2 = 0$.
"2" represents a straight line with slope K_1.
"3" represents a straight line parallel to "2" passing through point n where $mn = \frac{1}{2}\left(\frac{d\delta}{dT}\right)^2_{\text{at}\,\delta=\delta_o}$.

Referring to Figure 1., the vertical straight line mn represents the initial kinetic energy $\frac{1}{2}\left(\frac{d\delta}{dT}\right)^2_{\text{at}\,\delta=\delta_o}$. From the diagram,

$$bd = cd + ac - ab$$
$$= mn + ac - ab$$

$$\therefore bd = \tfrac{1}{2}\left(\frac{d\delta}{dT}\right)^2_{\text{at}\,\delta=\delta_o} + K_I(\delta - \delta_o) - [\psi(\delta) - \psi(\delta_o)]$$

$$\therefore bd = \tfrac{1}{2}\left(\frac{d\delta}{dT}\right)^2$$

Thus, the vertical ordinates of the hatched area shown in Figure 1. represent the

A NEW GRAPHICAL METHOD FOR THE TRANSIENT STABILITY OF ELECTRIC POWER SYSTEMS

By

Dr. MEDHAT ADIB NASR *

Introduction

The proposed new graphical method gives a simple criterion for the determination of transient stability of a power system in which the synchronous machinery can be reduced to two equivalent machines. The method is based upon the construction of a chart from which the quantity $\left(\frac{d\delta}{dt}\right)^2$ can be determined directly. The chart determines the values of the swing angles δ where the angular velocity $\frac{d\delta}{dt}$ is zero in which case the machine remains stable. If the chart indicates that $\frac{d\delta}{dt}$ does not become zero the rotor will continue to move and synchronism lost.

The range of oscillations of the machine is defined on this chart as the range at which the quantity $\left(\frac{d\delta}{dt}\right)^2$ is positive. Thus, the maximum and minimum rotor angles reached during the oscillations may be determined. The rotor angle at which $\left(\frac{d\delta}{dt}\right)^2$ is maximum i.e. at which the kinetic energy is maximum, determines the position at which the potential energy is minimum, according to the law of conservation of energy. This position determines the final steady state position of the system which may be reached if the oscillations will be damped out.

The chart can thus give information about (a) the power system stability; (b) the range of the machine oscillations, and (c) the final steady state position if the system is stable.

Any disturbance is characterised by the initial conditions and certain values for the system parameters. According to these values the corresponding curves of the chart are chosen.

The proposed method is considerably less laborious than a step-by-step solution of comparable accuracy. The effect of transient saliency of synchronous machines can be introduced into the solution if desired. Examples are presented to check the accuracy of solution by this new graphical method and to illustrate the applications of this method.

Theory and Development of the New Graphical Method

The power input to a synchronous machine is consumed in three ways: power output, power consumed in damper windings and other losses, and power used in accelerating the rotating part of the machine (this may be either positive or negative) thereby altering its kinetic energy.

Considering a synchronous machine having constant power input, and in which the power absorbed in damping is proportional to the angular velocity; and assum-

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determination of voltage variation on traction networks when loaded by (m) trainsets.

The suggested methods enable design engineers to estimate the number of traction converter stations for a certain required traffic load.

Appendix

Equation (33) will now be derived.

Referring to figure (4) and from similarities of triangles, then

$$(Y_1 Z_1) \text{ part } (1) = \frac{(X_1 Z_1)(XX_1)}{(XG_1)} \qquad (34)$$

Combining equations (26), (26) and (34), then

Also referring to equation (32) putting it in a generalised case, then

Combining equations (26) (26) and (34) then

$$(Y_1 Z_1) \text{ part } (1) = \frac{q I_1 \; r_{d1}}{w \sum_{p=o}^{4} r_{dp}} = \frac{q I_1 \; r_{d1}}{\sum_{p=o}^{4} r_{dp}} \qquad (35)$$

For a generalized analysis then,

$$(Y_p Z_p) \text{ part } (1) = q \, \frac{I_p \sum_{t=o}^{p-1} r_{dt}}{\sum_{p=o}^{h-1} r_{dp}} \qquad (36)$$

$$\text{And } (Y_p Z_p) \text{ part } (2) = q \, \frac{I_p \sum_{t=p}^{m} r_{dt}}{\sum_{p=h}^{m} r_{dp}} \qquad (37)$$

$$Z_h = \sum_{p=1}^{(n-1)} (Y_p Z_p) + (Y_h Z_h) + \sum_{p=h+1}^{m} (Y_p Z_p) \qquad (38)$$

Substituting equations (36), (35) and and (37) in respective terms of equation (38) we get;

$$Z_h = q \left[\frac{A+B+C}{D_1} \right] \qquad (39)$$

where;

A, B and C are given by equations (21, (22) and (23) respectively

$$D_1 = \sum_{p=o}^{(h-1)} I_{dp} \sum_{p=h}^{m} I_{dp} \qquad (40)$$

Dividing equation (20) by equation (39) we get;

$$\frac{t_h}{Z_h} = \frac{:i}{q = D} \qquad (41)$$

Combining equations (24), (40) and (41) results in equation (33).

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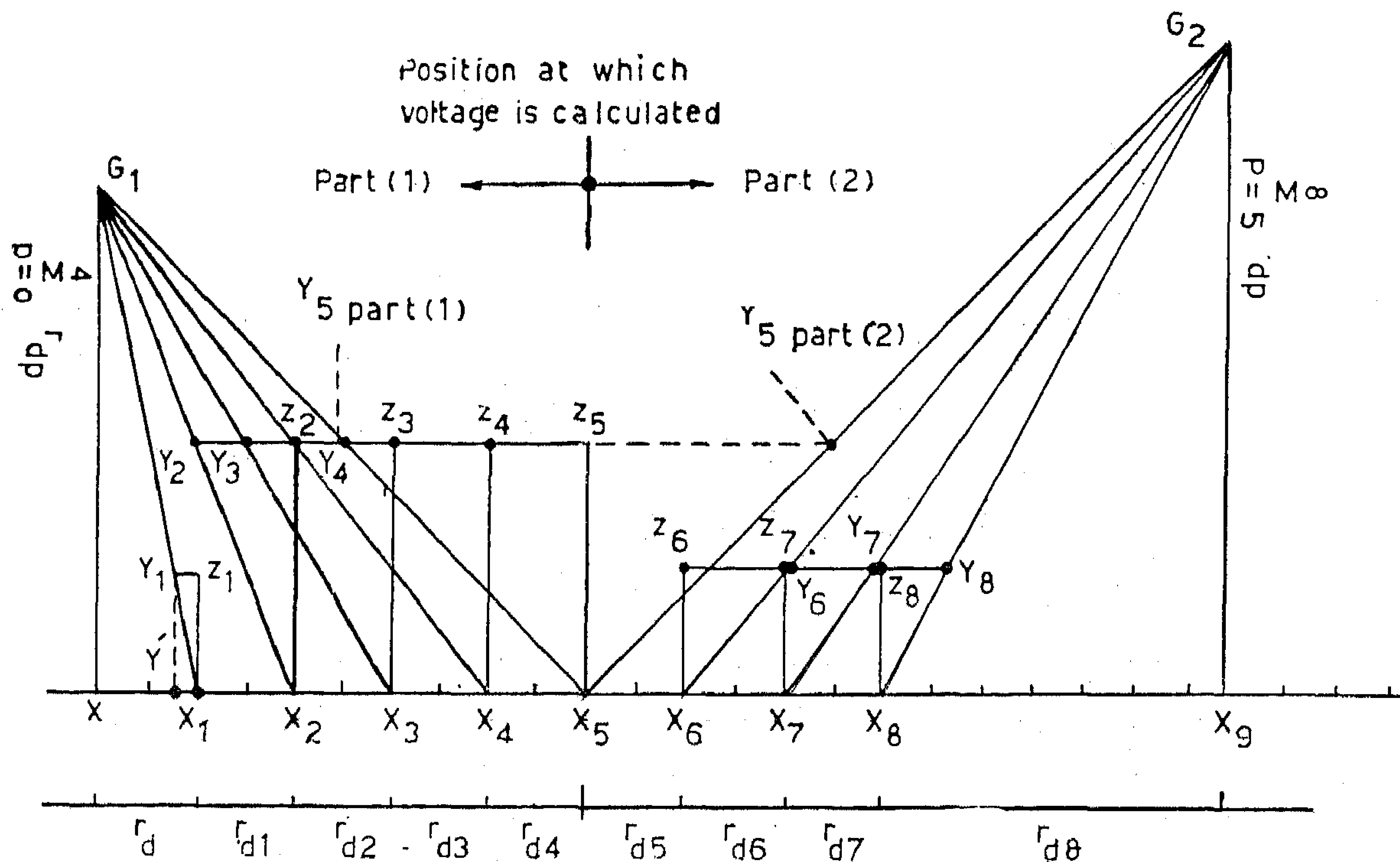


FIGURE (4) CONSTRUCTION OF THE GRAPHICAL METHOD FOR THE SPECIFIC EXAMPLE GIVEN

DRAW TO SCALE (q cm/amp) THE LINES (X_1Z_1) (X_8Z_8) AT RIGHT ANGLES TO (XX_9) ------------(28)

$X_1Z_1 = q I_1$, $X_2Z_2 = q I_2$; etc ----------------------(29)

AT POINTS Z_1, Z_2 ---- Z_8; DRAW PARALLEL LINES TO (XX) TO INTERSECT (G_1X_1)----(G_8X_8) AT POINTS $Y_1, Y_2, \ldots Y_8$ RESPECTIVELY.

CLEARLY;

$$(Y_5Z_5)_{\text{part (1)}} = (Y_5Z_5)_{\text{part (2)}} \quad \text{------------------ (30)}$$

$$\eta_5 = Y_1Z_1 + \cdots + Y_4Z_4 + (Y_5Z_5)_{\text{part (1)}} + Y_6Z_6 + \cdots + Y_8Z_8 \quad \text{------------------ (31 a)}$$

OR;

$$\eta_5 = Y_1Z_1 + \cdots Y_4Z_4 + (Y_5Z_5)_{\text{part (2)}} + Y_6Z_6 + \cdots + Y_8Z_8 \quad \text{------------------ (31 b)}$$

Generally equations (31a) and (31b) can be written in the form;

$$\eta_5 = \sum_{p=1}^{4} (Y_p Z_p) + (Y_5 Z_5)_{(1)\,or\,(2)} + \sum_{p=6}^{8} (Y_p Z_p) \quad \text{------------- (32)}$$

Using equation (32) and the graph of figure (4); (η_5) can be determined. (ε_5) can be deduced once (η_5) is evaluated.

This is due to the fact that the ratio of proportionality (F) governing the relation between (ε_h) and (η_h) is given by the expression;

$$F = \frac{\varepsilon_h}{\eta_h} = \frac{\sum_{p=0}^{h-1} r_{dp} \sum_{p=h}^{m} r_{dp}}{q \sum_{p=0}^{m} r_{dp}} \quad \text{------ (33)}$$

Thus (ε_h) can be determined graphically.

This enables the design engineer to determine the voltage at any point and to determine the suitable position of the next traction converter station.

Conclusion

A general approach has been taken for the development of a systematic anallyatical and graphical methods for the

$$C=\sum_{p=h}^{m} I_{dp} \sum_{p=1}^{(h-1)} \left(I_p \sum_{t=0}^{(p-1)} I_{dt} \right) \quad (23)$$

$$D=\sum_{p=0}^{m} r_{dp} \quad (24)$$

According to the foreseen traffic conditions the distribution ot traction locomotives can be distributed on the line.

The equivalent circuit can be drawn. The quantities I, A, B, C. and D (using equations 14, 21, 22, 23, 24 respectively) can be easily determined for a certain particular point.

Thus (ε_h) is evaluated for this position of locomotive numbered as (h) by the help of equation (19).

Once (ε_h) is known then the voltage at the position of locomotive number (h) can be evaluated. By this way the minimum voltage suitable for the reasonable operation of traction motors can checked.

At the position where the voltage feeding the locomotive is found to be lower than the reasonable minimum limit operating traction voltage; then a second traction station should be placed.

Graphical Analysis

The graphical method is actually an interpretation of equation (20) i.e. a graphical evaluation of (ε_h) at any point of the traction network. To illustrate this method let us analyse the following example of an (1500) V traction catenary and 5 minute traffic load of a certain suburban line. This special simplified case is illustrated by figure (3), where :

- equivalent resistance of rails ant line components per km = 40 milliohm
- one train set (or one locomotive) equivalent resistance for electric traction circuit = 8 milliohm
- current per locomotive or traction train set = 400 amp
- number of train sets loaded on one traction station = 4 x 1 + 4 x 2
  i.e. trainsets at positions (i), (vi), (vii), and (viii) are double units while at positions (ii), (iii), (iv) and (v) they are single units.

The graphical solution in figure (4) is for the special case of determining (ε_5) of figure (3). The following steps are used to construct figure (4).

— draw to scale (w cm/milliohm) the lines (XX_9 (XG_1) and (X_9 G_9) which are perpendicular to each other (25)

$$-XX_5 = XG_1 = W \sum_{p=0}^{4} r_{dp} \quad (26)$$

$$-X_5X_9 = X_9G_2 = W \sum_{p=5}^{8} r_{dp} \quad (27)$$

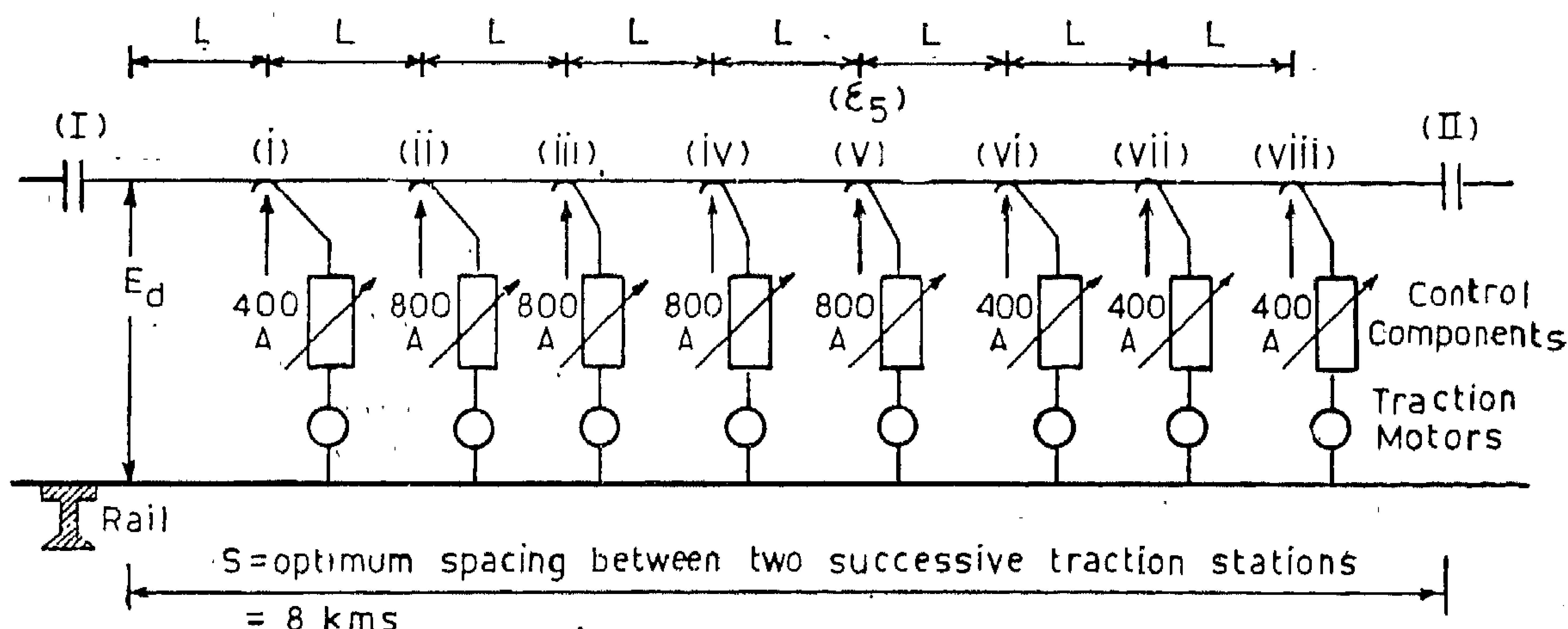


FIGURE (3) EXAMPLE ILLUSTRATING A SPECIAL SIMPLIFIED CASE FOR GRAPHICAL METHOD

Putting,

$$N = \left[\sum_{p=0}^{(m-1)} I_{dp} + \frac{100}{6} r\right] \quad \text{---------- (11)}$$

In equation (10) we get

$$I_d = \left[\frac{E_d}{N}\right] - \left[\frac{\sum_{p=1}^{(m-1)} I_{dp} \sum_{t=1}^{p} I_t + \frac{100}{6} r \sum_{t=1}^{(m-1)} I_t}{N}\right] \quad \text{--(12)}$$

In equations (10) and (12) respectively; replacing;

$$r_{dm} = \left(\frac{100}{6}\right) r \quad \text{---------- (13)}$$

and $I = (E_d / N)$ ---------- (14)

This results in:

$$N = \sum_{p=0}^{m} I_{dp} \quad \text{---------- (15)}$$

$$\text{and } I_d = I - \sum_{p=1}^{m} r_{dp} \sum_{t=1}^{p} I_t \quad \text{---------- (16)}$$

Once again referring to the equivalent circuit diagram and equation (2) it can be deduced that :

$$E_h = E_d - I_d r_d - \sum_{p=1}^{(h-1)} \left[(I_d + \sum_{t=1}^{p} I_t) r_{dp} \right] \quad \text{--- (17)}$$

Comining equations (16) and (17) results in

$$E_h = E_d - I \sum_{p=0}^{(h-1)} I_{dp} + \left[\frac{r_d \sum_{p=1}^{m} (r_{dp} \sum_{t}^{p} I_t)}{\sum_{p=0}^{m} r_{dp}}\right] + \sum_{p=1}^{(h-1)} \left\{ r_{dp} \left[\frac{\sum_{p=1}^{m} (r_{dp} \sum_{t=1}^{p} I_t)}{\sum_{p=0}^{m} r_{dp}} - \sum_{t=1}^{p} I_t \right] \right\} \quad \text{--(18)}$$

$$\text{Let } \mathcal{E}_h = E_h - E_d + I \sum_{p=0}^{(h-1)} r_{dp} \quad \text{---------- (19)}$$

Therefore combining equations (18) and (19) as well as arranging terms we get :

$$\mathcal{E}_h = \frac{A+B+C}{D} \quad \text{---------- (20)}$$

Where;

$$A = \sum_{p=0}^{(h-1)} r_{dp} \sum_{p=h+1}^{m} \left(I_p \sum_{t=p}^{m} r_{dt}\right), \quad \text{------(21)}$$

$$B = I_h \sum_{p=0}^{(h-1)} I_{dp} \sum_{p=h}^{m} I_{dp}; \quad \text{----------(22)}$$

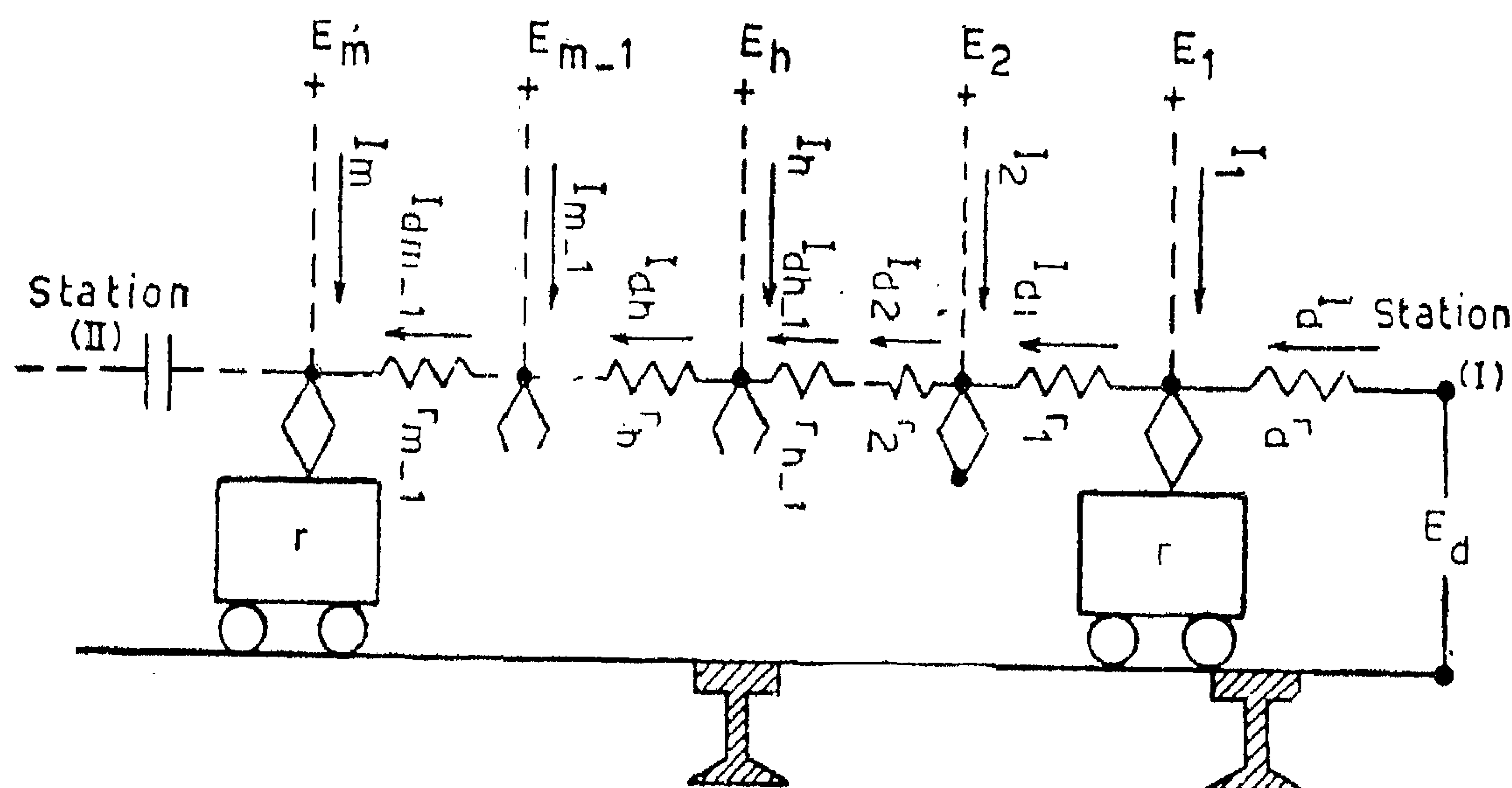


FIGURE (2) EQUIVALENT CIRCUIT

the pantographs of trainsets (h) and (h+1).

I_{d1} current in catenary between pantographs of first and second locomotives.

I_{dh} current in traction line portion lying between pantographs of locomotives (h) and (h+1).

e back e.m.f. of locomotive.

r equivalent resistance of locomotive traction circuit.

Analysis of equivalent circuit

The voltage at the terminals of the first locomotive is :

$$E_3 = E_d - (I_d r_d + I_{d1} r_1 + I_{d2} r_{d2}) \quad (1)$$

Therefore ;

$$E_h = E_d - \sum_{p=o}^{P=h-1} I_{dp} r_{dp} \quad (2)$$

In equation (1) when (p = o) then ;

$$I_{do} = I_d \text{ and } r_{do} = r_d \quad (3)$$

Again referring to the equivalent circuit we get ;

$$E_d = (e - I_m r) + \sum_{p=o}^{p=m-1} I_{dp} r_{dp} \quad (4)$$

In designing electrical machines (8), the difference between the terminal voltage and the back e.m.f. is about 6 %

$$e = 0.94 E_m = 0.94 \left[E_d - \sum_{p=o}^{p=h-1} I_{dp} r_{dp} \right] \quad (5)$$

Also for the currents we have following relationships:-

$I_{d1} = I_d + I_1$,

$I_{d2} = I_{d1} + I_2 = I_d + (I_1 + I_2)$

Therefore ;

$$I_{dp} = I_d + \sum_{t=1}^{p} I_t \quad (6)$$

Combining equations (4), (5) and (6) results in ;

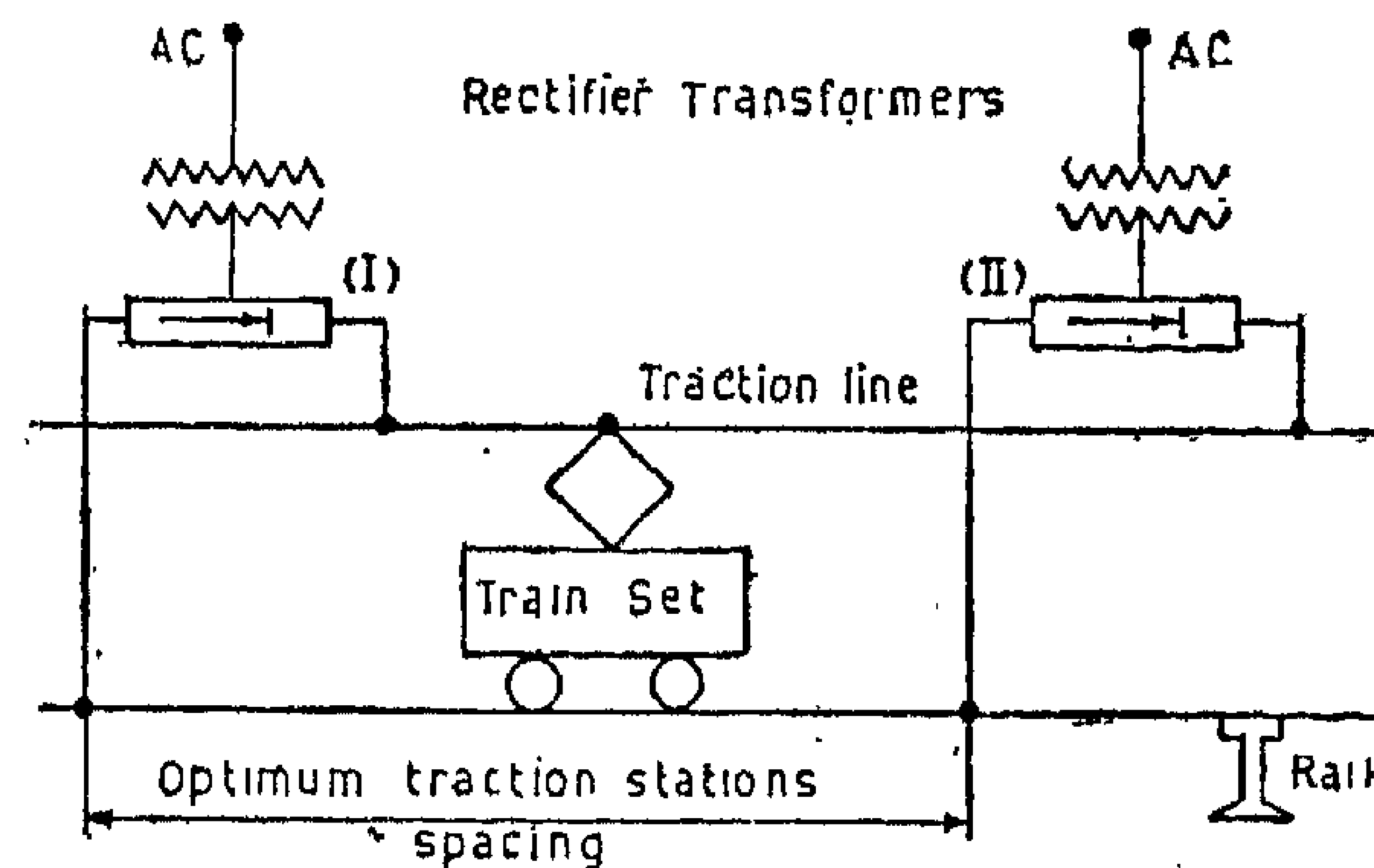


FIGURE (1) SIMPLIFIED DIAGRAM OF TWO TRACTION STATIONS TO ILLUSTRATE THE PROBLEM

$$E_d = 0.94\, E_d - \sum_{p=o}^{m-1} I_{dp} r_{dp} - I_m r + I_d \sum_{o=o}^{m-1} I_{dp} + \sum_{p=2}^{m-1} r_{dp} \sum_{t=1}^{p} I_t \quad (7)$$

Equation (7) reduces to ;

$$E_d = \frac{100}{6} \left[0.06\, I_d \sum_{p=o}^{(m-1)} r_{dp} + 0.06 \sum_{p=1}^{(m-1)} \left(r_{dp} \sum_{t=1}^{p} I_t \right) \right] - \frac{100}{6} I_m r \quad (8)$$

Combining equations (6) and (8) for (I_m) and arranging terms we get :-

$$E_d = I_d \left[\sum_{p=o}^{(m-1)} r_{dp} + \frac{100}{6} r \right] + \left[\sum_{p=1}^{(m-1)} r_{dp} \sum_{t=1}^{p} I_t + \frac{100}{6} r \sum_{t=1}^{(m-1)} I_t \right] \quad (9)$$

From equation (9) we get :-

$$I_d = \frac{\left[E_d - \left[\sum_{P=1}^{(m-1)} I_{dp} \sum_{t=1}^{p} I_t + \frac{100}{6} r \sum_{t=1}^{(m-1)} I_t \right] \right]}{\left[\sum_{P=0}^{(m-1)} I_{dp} + \frac{100}{6} r \right]} \quad (10)$$

DESIGN OF OPTIMUM SPACING FOR CONVERTER TRACTION STATIONS

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Dr. Techn., Cand. Techn. Sc. SM IEEE

Summary

Suburban transport around big cities continue to be carried out by direct current electrification. The present paper enables design engineers to estimate voltage contitions at any point of an (m) terminals traction network and the optimum spacing between two successive converter traction stations.

Introduction

Railways play a major role in transportation. This situation has made it imperative for the railway industry to rationalize itself for more efficient optimum designs to meet economic needs of the nation (1), (2), (3). It has long been recognized (4), (5), (6), (7), that the low voltage, direct current, series wound motor is well suited for traction purposes. The motor performance depends on the voltage of the traction network feeding the traction locomotive at the different positions along the overhead traction line. Figure (1) illustrates the basic circuit of a traction system. The analysis enables the operating and design engineer to:

i) evaluate voltage drop at any point in the traction network.

ii) minimum voltage under which traction motor should operate satisfactorily.

iii) estimate under certain traffic load the position after which another traction converter station should be present.

Nomenclature

E_d , I_d traction station output terminal voltage and current.

E_l Catenary terminal voltage at the position of the first locomotive.

E_h voltage at the terminals of the h (th) locomotive.

E_m voltage at the terminals of the last locomotive on this section connected to station (I).

I_I current for first locomotive.

I_h current for h (th) locomotive.

I_m current for m (th) locomotive i.e. last locomotive operating on this section of station (I).

r_d equivalent resistance of rail and traction line components between traction station (I) and first locomotive.

r_{dI} resistance of that part of traction line and rail components lying between first and second locomotive.

r_{dh} resistance of traction line and rail components lying between

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Ninth Program :

9—1 The recovery of black liquer from pulp mills.

9—2 Minerals from sea water bittern.

9—3 Potash fertilizer from molasses and vinasses from waste of sugar industry.

9—4 The industrial utilization of rice hulls.

9—5 Recovery of by-products flourine from Super Phosphate manufacture.

9—6 Bp-products in tyres industry and their uses.

9—7 Pollution of detergent industry.

9—8 Utilization of disposal water in starch industry.

9—9 Scrap Products in tyres industry and their uses.

9—10 Recovery and utilization of sulpheric acid from organic waste.

9—11 Treatment of industrial waste.

Tenth Program :

10—1 Solid State Physical Electronics.

10—2 Solid State Devices.

10—3 Integrated Circuits Technology.

10—4 Microwave Solid State Devices.

10—5 Digital Computers.

10—6 Automatic Control.

10—7 Optimization and Operational Research.

10—8 Industrial Electronics.



Appendix

Contents of the ten E.S.P. Programs

First Program :

1—1 Industrial Electronics.

1—2 Data Processing for Engineers.

1—3 Introduction to Electronic Computers in industry.

1—4 Industrial Management and quality control.

1—5 Automatic Control in Industry.

Second Program :

2—1 Application of industrial Electronics

2—2 An Introduction to Electronic Computers and their applications in the industry (Computer Apperciation Course).

2—3 Applications of Automatic Control in Factories.

2—4 Material Handling Inside Factories.

2—5 Applications of Operational Research in the industry.

Third Program :

3—1 FORTRAN.

3—2 Modern Electronic Technique in industry.

3—3 Measuring Techniques in industry.

3—4 Modern Physics.

3—5 Numerical Methods.

Fourth Program :

4—1 Insentive schemes in Industry.

4—2 Solid state Devices.

4—3 Scientific Programming Languages.

4—4 Industrial Electronic and Automatic Control.

Fifth Program :

5—1 Reliability, Probabity and information Theories in industry.

5—2 Quality Control.

5—3 Decision Theory.

5—4 Operations Research.

Sixth Program :

6—1 Qualitp Control.

6—2 Production planning and control.

6—3 Work study and performance rating techniques.

6—4 Statistical systems and its applications to industry.

Seventh Program :

7—1 Planning operations of preventive

7—2 Preventive Maintenance by PERT system.

7—3 Planning operation of lubricating systems for industry.

7—4 Storing, handling and quality control of fuel and lubricating oils.

7—5 Periodical replacement of lubricating oils in industrial equipment.

7—6 Lubricating oils and its effect on equipment maintenance.

7—7 Maintenance cost control.

7—8 lubrication and maintenance Economics.

Eight Program :

8—1 Work study.

8—2 Ergonomics.

8—3 Job Evaluation.

8—4 Time Measurements.

8—5 Incentive Schemes.

Table 1

Summery of the ten E.S.P. Programs.

Year	Program Number.	Number of participants	Number of Companies	Number of Lectures	Number of days/week	Total Number of days.
First year 1969/1971	1	43	17	5	3	12
Second year 1970 1971	2 3	36 27	12 11	5 5	3 3	12 9
Third year 1971/1972	4 5	38 28	8 10	4 4	3 3	9 9
Fourth year 1972/1973	6 7	13 55	5 19	8 5	3 3	9 9
Fifth year 1973/1974	8 9 10	28 10 14	9 4 7	13 8 8	4 4 4	8 8 8
Years. Total Five	10 Programs	292 members	102 companies	61 lectures		93 days.

COUNCIL FOR SCIENTIFIC CONSULTANTS (C.S.C) : ELECTRONICS

A council was formed in the Society of Engineers Alexandria comprising some notable elderly engineers from both the indstry as well as the University of Alexandria. It was given the name Council for Scientific Consultants (C.S.C). such group was to give advice to E.S.P, plan and propose programs as well as advance the names of leading specialists capable of participating as lesturers.

Assessment of the Ten Programs :

As shown in the Appendix, 292 engineers representing 102 companies attended the 10 E.S.P. programs which were given in the last five pears. 61 lectures were presented; while the total number of dags were 93.

Based on the experience gained in such programs one can say that on the average each program was attended by 30 engineers representing 10 companies or in other words each company is presented by three members each program. Six lectures are given on the average every program lasting about 9 days.

Some Results of the E.S.P. programs :

A sample of experiences met as a result of the E.S.P. could be clearly demonstrated by the following events :

1 — The society received a letter from a leading Alexnadria firm requesting that all its engineers should have the benefit of attending future E.S.P. programs. In their belief that would save the company's time as well as expenses when sending the same to Cairo.

2 — A company director told me during the tea intermission that before attendng the program he received a new project in which «thyrestors» played a leading part. Being not familiar with its function he deliberately set the idea aside. I was told that after attending the program it helped him to realize its importance and a serious step was taken to make full advantage of such improvement in his company.

3 — After attending another program in which the probability theory was one of the topics; a young engineer working in a cotton pressing company made a satistical survey on steel hoop tolerances that were rejected by his company. The application of such theory showed a sizable reduction in the rejected hoops. The E.S.P. then wrote a letter of recommendation which was reciprocated favourably by the company's chairman.

4 — One cement company chairman attending an E.S.P. program was impressed by one of the uses of "rice hulls" (an industrial waste) as a raw material in the cement industry. He proposed the start of research on that point; the lecturer at the time being invited to supervise that research in the cement company.

Conclusion :

We have given a brief survey on the start and evolution of the E.S.P. Programs. Beside certain gains in the Society's budget and added membership; the program, in itself was considered successful with almost half the Society's members having attended such programs in the last five pears.

We greatly hope that such idea of transferring engineering information could be used as a model for other developing countries and we are certainly willing to give all possible assistance and help if nedded.

son he mentioned that should these directors appreciate the engineering knowledge that would help greatly in the better understanding and functioning within his company.

The Second E.S.P Program :

Due to the climatic conditions prevailing in Egppt; the most convenient time for lectures was considered to start from the month of Octaber and end not later than the month of May. During such period the availability of Universitp Lecturers as well as that of the participating engineers were best met. Under such condition it was thought proper to start the second program on the next fiscal year 1970/71.

The consideration of another general program directed to the higher managerial staff was decided upon to give the opportunity for more directors to attend the E.S.P programs. Five lectures were selected for the second program which started on the 15 th December 1970 and lasted for four weeks three days a week. The idea was successful with the attendance of thirty six directors, representing twelve companies. At the end of the second program H.E the Mayor of Alexandria presented the certificates of attendance in a large tea party held in the Society's building.

The Evolution of the E.S.P Programs :

The result of the first two programs, however, was the presence of nearly eighty directors representing some thirty companies. Such achievement was considered a successful start. Meanwhile many young engineers requested that future programs be directed towards their interest and it was thought this would be the aim of the third program which was to start on March 1971. The attendance were to be engineers having from five to ten years of experience and hence the program was planned to be more academic. The appendix gives a clear idea of the contents of such program as well as the contents of the programs that followed.

On the third year of E.S.P. (1971/1972) two more programs, with a total of 66 engineers attendants representing 18 companies. More emphasis being given to insert production engineering courses to complement the everall picture of given courses.

In the fourty year two more programs were prepared; namely the sixth and seventh programs. The sixth program, however, was directed totally to production engineering, while a new idea was introdcded in the seventh program. Preventive maintenance was the title chosen and it was considered suitable to invite the specialists of two leading oil companies to participate. One week was allotted to each company in which each presented its experiences in that field. Moving pictures as well as lantern projections were used as aids for demonstration. The third week was left to faculty professors specialized in the same field. The last day, however, was left for open discussion attended by all three groups. The seventh program was a success attended by some 55 engineers representing 19 different companies.

Three programs were introduced in the fifth year ; each progrom lasting two weeks comprising eighth days of lectures. The eighth program was concerned with production engineering ; while the ninth program was an approach to a new problem facing industry; namely : «Industrial waste» in which thirteen topics were considered. The participants of that program were mostly chemical engineers. The tenth program was devoted to the latest developments in industrial electronics.

gram to the higher managerial staff. The purpose was two-fold; not only the managers would appreciate the program but also they would not mind sending their "second line" engineers to attend future programs. The managerial staff was considered in this respect to be those engineers having experience exceeding ten years and the courses thus selected were those which would help a managing director.

On such a basis the first engineering scientific program was set to start on the 26 th of March 1970 with some eighty known companies and works in the Alexandria Governate being invited to attend that program. The fees being set at 10 L.E. which were in reality nominal fees representing the attitude of the Society of being non-profitable. The contents of the first program as well as the ten E.S.P. programs are however given in the Appendix.

The first program was designed as a four week program, three days a week was considered appropriate. Lectures started at 6 P.M. to 9 P.M.; so as not to interfere with the working time of the engineers in their companies. A fifteen minutes intermission for tea was proposed. Such intermission was considered a social gathering and get-together for all engineers participating in the program.

Adminstrative Organization of the first program :

It was foreseen that the success of the E. S. P. Programs would, in fact, be a consequence of a good admistrative organization. An executive supervisor for each program was nominated to head the team of adminstration and follow-up group. A dynamic personalitp possessing a great quality of leadership were his basic qualifications. The Society's treasurer was chosen as his cooperator regarding money transactions and budget making for which a special bank account was opened.

The secreterial part of the team consisted of three persons including an assistant and a typist. Since each engineer attending the program was to recieve a special folder containing all written lectures and documents in English, a specialist in arabic handwritting was required to write the participants' name on the folder. Such person was added to the secreterial group and helped in writing the advertisements within the Society's premises as well as the final attendance certificates.

The job of the secreterial group was to take care of all correspondance, to register the engineers attending each program, to help in copying and typewritting the lectures text, to arrange folders etc.. All efforts being directed, however, to fulfill the attendants demands and comfort. The preparation of the main lecture hall was another concern of the team including the arrangement of two black boards, a lecturing as well as a lecturer's stands, some fifty easy chairs etc. A special register book was set al the Society's entrance in order to register the daily attendance of participating engineers.

It was encouraging, however, to find that the number of attending directors and engineers in the first program was forty three representing seventeen companies. At the end of the four week session; a tea cermony was organized attended by H. E. The Mayor of Alexandria in which he presented the certificates of attendance.

An incident worth mentioning in that program concerning one company chairman who attended the program accompanied by seven of his directors. He requested the presence of his company treasurer and adminstrative director both being non-engineers. When asked the rea-

d — The encouragement of authership, translation and publications in the various fields of engineering sciences.

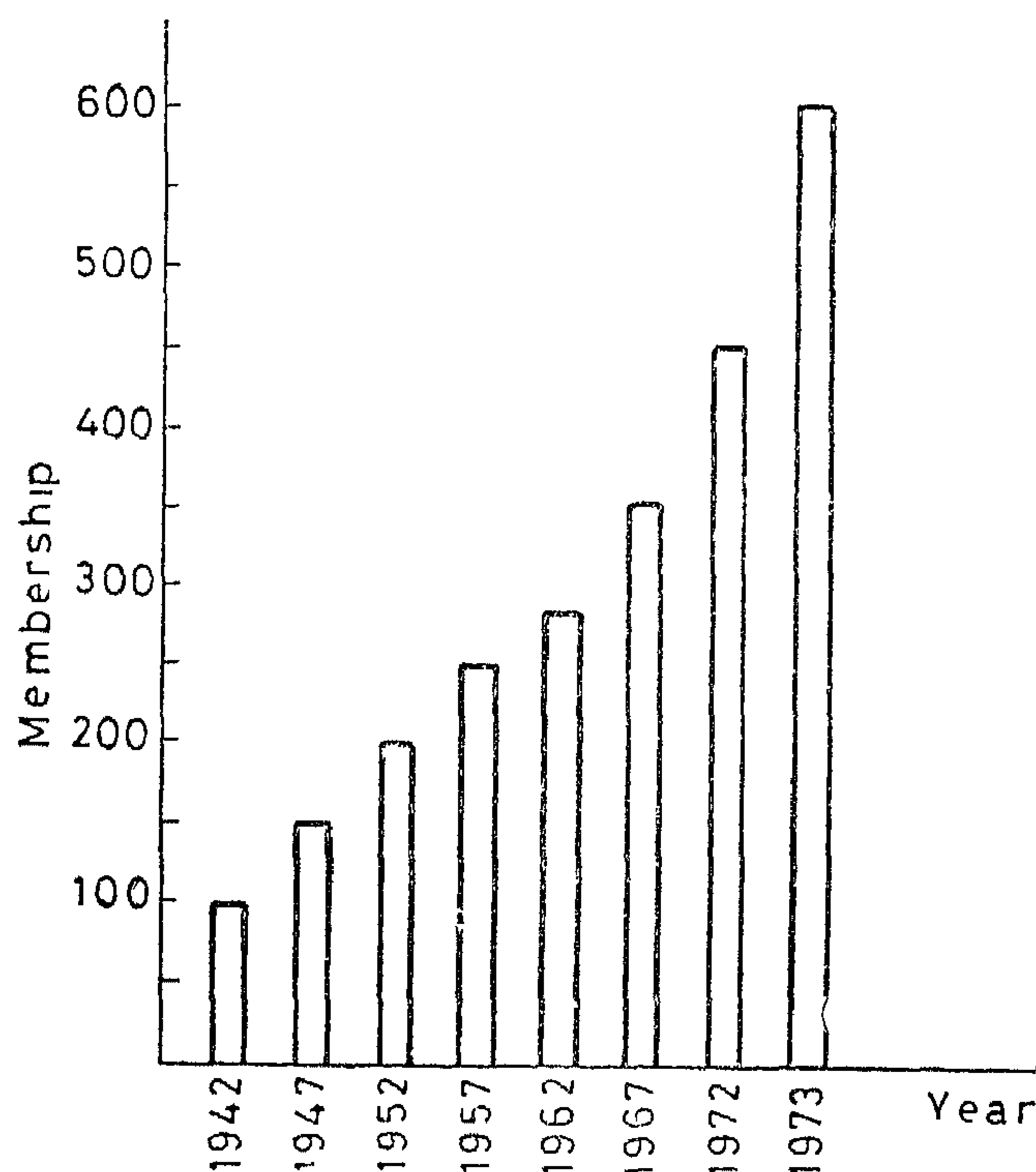
e — Encouraging scientific research and invention between the Society's members.

f — Establishing a scientific and engineering library together with lecture halls.

g — Organizing trips, travels and visits to study the engineering and industrial projects.

h — Initiation of cultural meetings to enforce the bonds between the Society's members in a way to achieve the transfer of engineering information.

Ever since its establishment, the Society of Engineers of Alexandria made many achievements and had the privlege of initiating the Engineering Conferences in the Arab World. The first Arab Engineering Conference, was held in the City of Alexandria in March, 1945. The evolution of the Society membership for a period of thirty years from 1942 to 1972 is shown on (fig. 1).



Preparations for the First E.S.P Program :

As has been mentioned previously; one of the main goals of the Society of Engineers Alexandria is to enforce the transfer of engineering information; not only to its members but also to all engineers in the Alexandria zone. It was on such a basis that the plan for, what we later named, the "Engineering and Scientific programs "E.S.P." was approved.

Certain goals, however, were put forward for the E.S.P. programs, in general, which could be summarized in the following four points; namely:

1 — The improvement on the scientific knowledge of the engineers working in the industrial area of Alexandria.

2 — To work towards the transfer of the most up-to-date scientific information and international technology to the the engineer by means of the most simple and easiest way.

3 — Encouraging the engineer in his factory or company to increase his scientific knowledge.

4 — The open discussion of the scientific problems met by the engineer in his work with University Specialists in order to reach the best solution to his problems.

When setting the plan for the first program; one of the points under discussion was what type of courses should be given and who was supposed to deliver them. A general engineering course was selected and the heads of the respective engineering departments where chosen; headed by the Dean of the Faculty of Engineering at that time. Another problem was then considered namely; what type of engineer is supposed to attend the first program. After several discussions it was decided to dedicate that pro-

THE E.S.P. A MODEL PROGRAM FOR TRANSFERRING ENGINEERING INFORMATION IN DEVELOPING COUNTRIES

BY PROF. F. BAHGAT Ph.D., M.Sc., B.Sc.*

INTRODUCTION :

The idea of an engineering program first evolved in December 1969, when on a consultation visit to one of the leading firms in Alexandria, the chairman of the company complained about his engineers losing contact with engineering information after few years of work in his Organization. Even though an adequate amount of periodicals and transactions were supplied to the firm's library; yet the result was that no body seemed to have the urge or the time to go through such publications. Such a state of affairs resulted in an inefficient type of engineer, unwilling or even incapable of introducing new ideas in order to improve his work which, in turn, affected adversely the production of the firm. When asked, in his opinion, what the solution would be, he suggested that appropriate engineering information in the form of refresher courses or the like ought to be given periodically in sort of lectures after work hours. It was at that moment that the part to be played bp the Society of Engineers - Alexandria, in such a plan, was introduced.

The idea was later put before the Society's Board. Despite the fact that the Society, at the time, suffered from some financial deficiency, yet the project was approved unanimously. The auther was elected General supervisor General Supervisor in charge of the program and was authorized to plan and organize the complete project.

The Society of Engineers — Alexandria :

The Society, a non-governamental body, was established in 1942 to serve the engineers in the Governate of Alexandria. Its purpose was to work in the field of scientific and engineering cultural services. This could well be defined, in the following manner:

a - The care for engineering services from both theoretical and practical aspects with due regard to their advancemet and publication.

b — Participation in the study and evolution of the engineering projects either constructional or industrial.

c — Assisting its members to pursue scientific research and to follow up recent developments in the engineering services and technology.

In order to achieve its goals the Society pursues the following ways :

a — Organizing lectures and conferences in various fields of engineering sciences.

b — The publication of lectures and the issue of an Engineering Magazine.

c — To facilitate the transfer of information, references and publications connected with the different fields of engineering services.

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Deputy Chairman, the Society of Engineers-Alexandria.

tion coefficient of moment of momentum for different port opening are shown in Fig. (9). It is clear from Fig. (9). that this coefficient increases with the increase of the port opening and the increase of mass rate of flow within 20% has no effect on it.

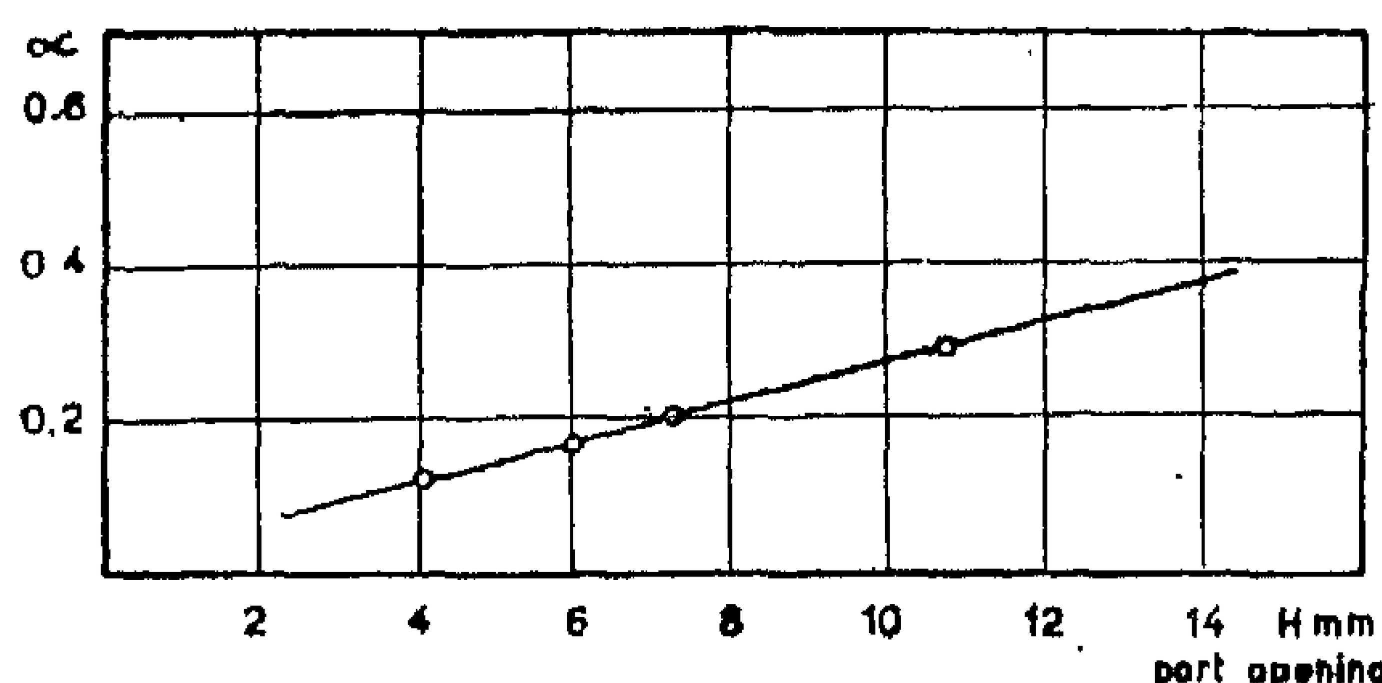


Fig. 9 Effect of port opening on the conservation coefficient of moment of momentum.

The effect of the engine speed on the conservation coefficient of moment of momentum was studied. The tangential velocity pattern shown in Fig. (10) is

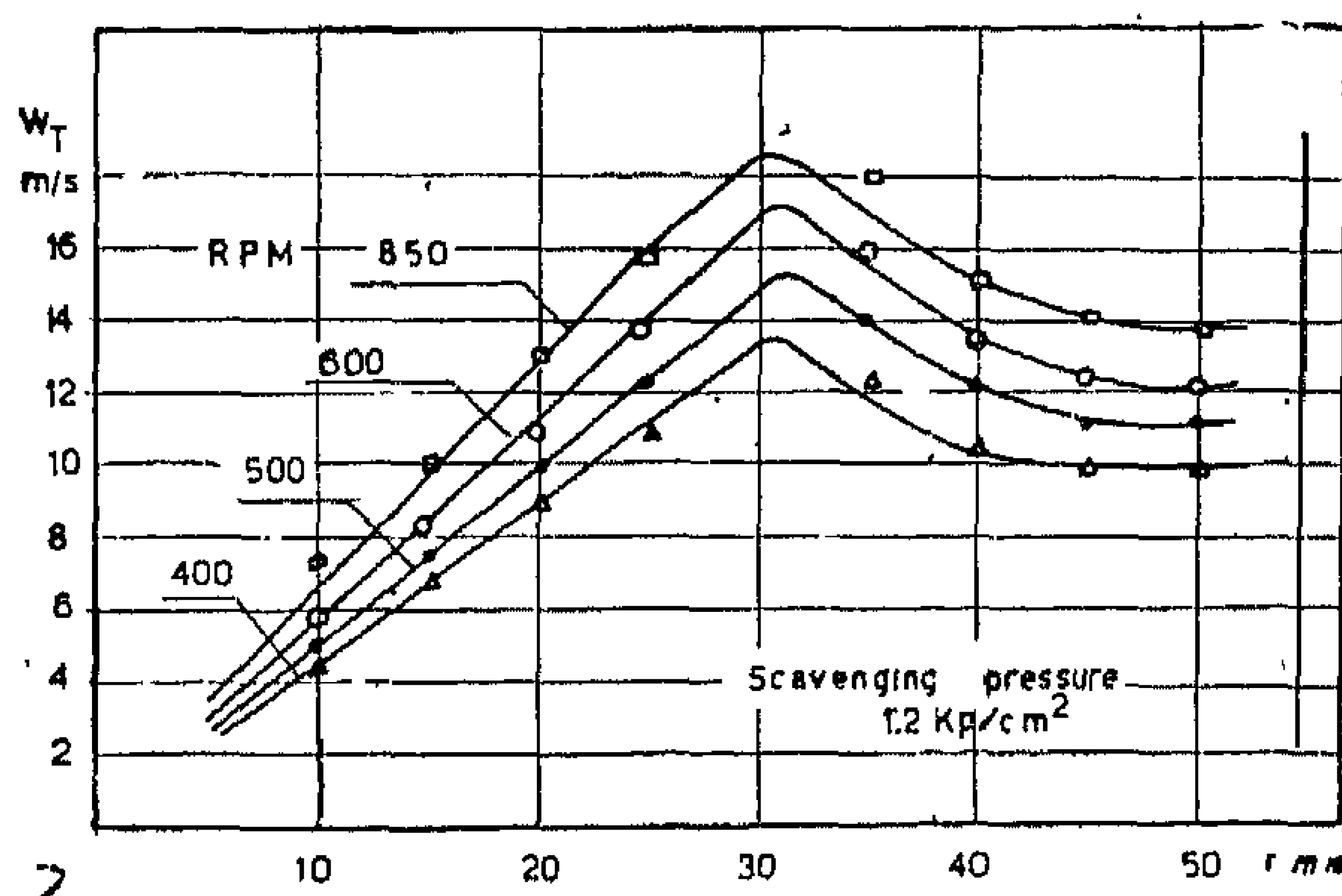


Fig 10 Effect of engine speed on the tangential Velocity pattern

measured inside the combustion chamber for different engine speeds. It was found that the character of the tangential velocity pattern is the same as in the case of static scavenging and the experimental evaluation of the conservation coefficient of moment of momentum was found to be 0.278, which is very near that value 0.28 calculated by theoretical formula (9). It does not depend on the engine speed. The total loss coefficient was found experimentally to be 1.21 for case (a) Fig. (5) and coincides with that calculated by formula (3) for the same area ratio.

Conclusions

On the basis of the analysis of experimental results the following may be concluded.

a) The conservation coefficient of moment of momentum is affected the area ratio. It increases with the increase of the port height.

b) The flow losses are not affected by the engine speed.

c) The total loss coefficient is affected by the port area and the pressure ratio across the ports.

d) The discharge coefficient has a maximum value with ports of tangential inclination 20° and vertical inclination 30°.

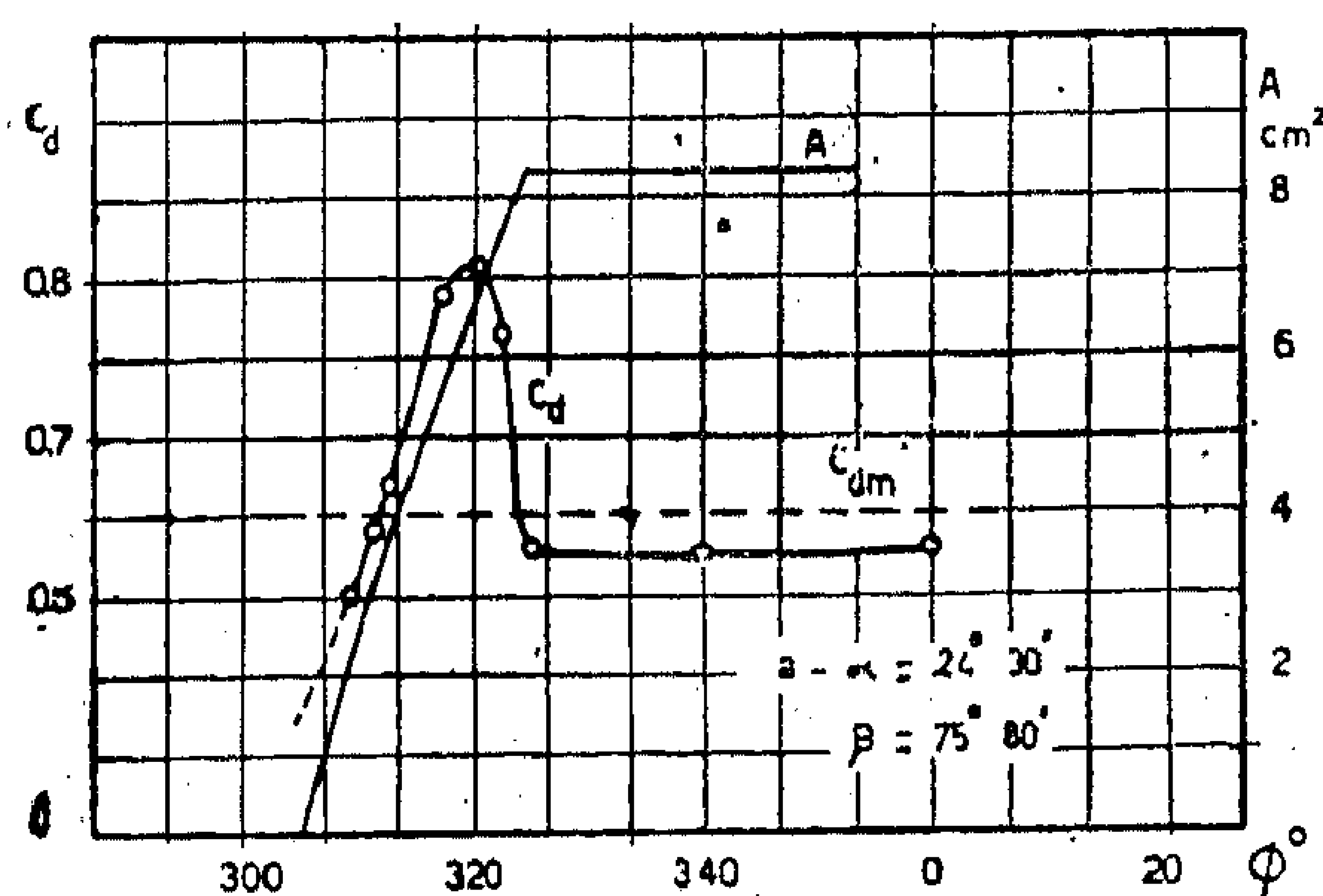
e) The evaluation of both coefficients by the suggested formula gave a close agreement with that obtained experimentally.

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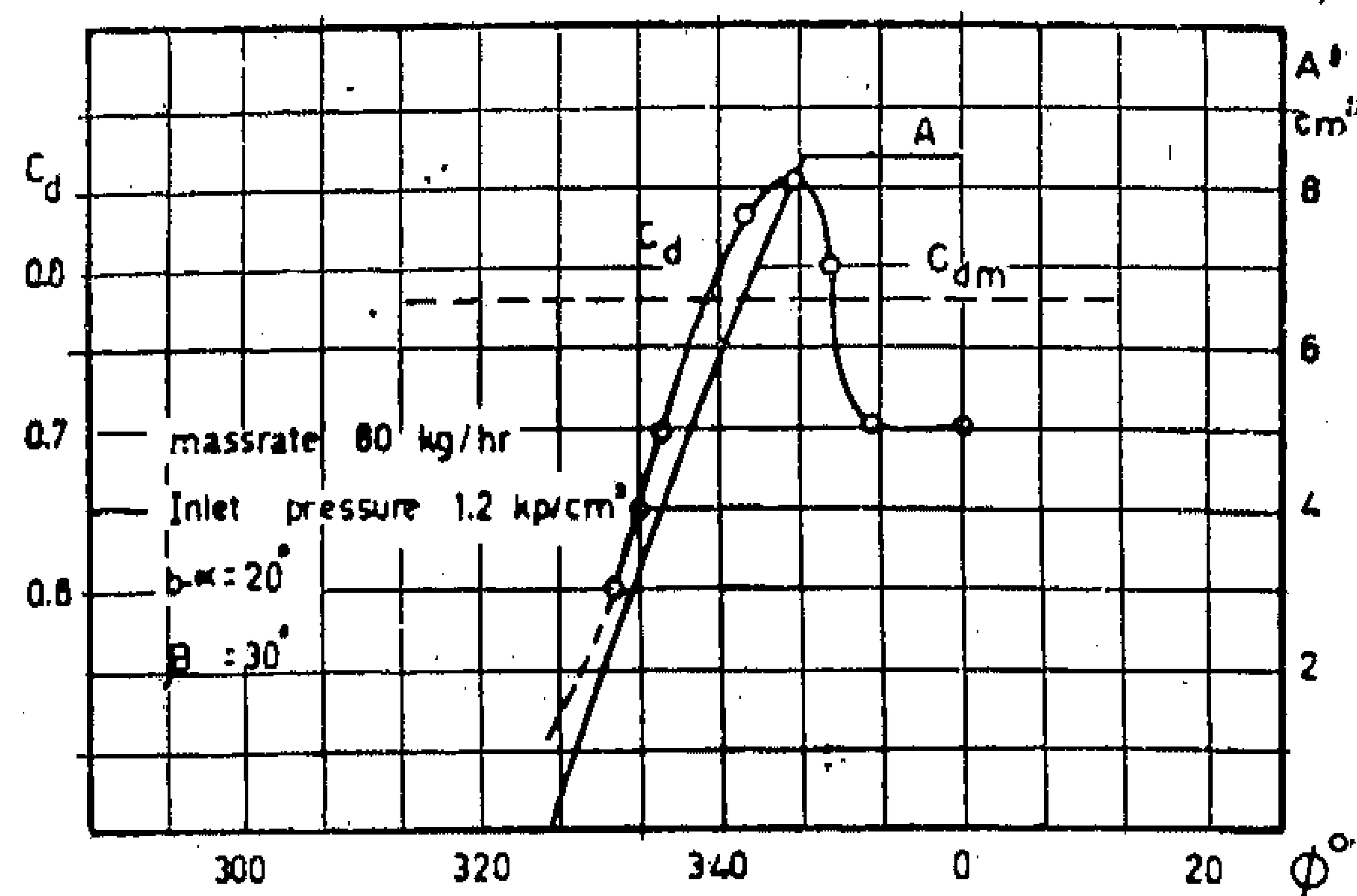


Fig. 5 Discharge coefficient with different vertical and horizontal inclination

jected with the increase of mass rate of flow at constant piston position as shown in Fig. (6).

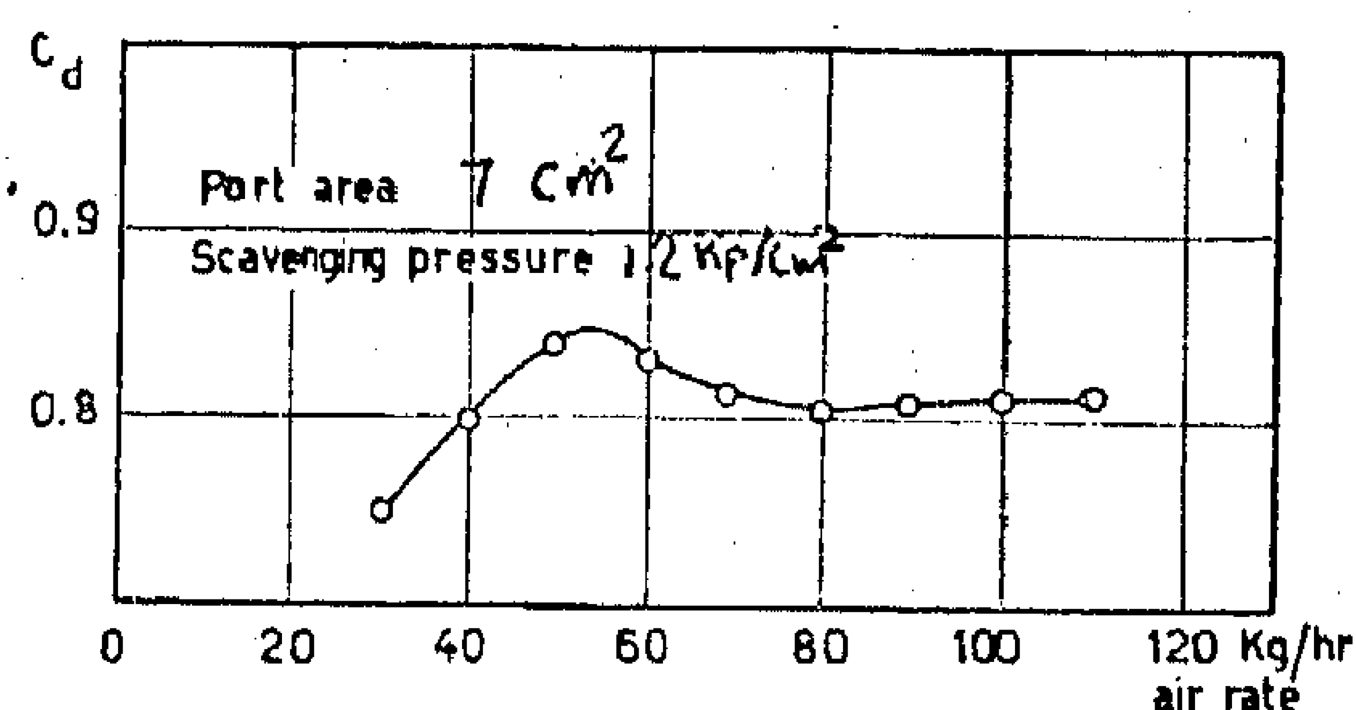


Fig 6 Effect of air mass rate on the discaharge coefficient

Also, the discharge coeffieicnt varies with the change of the tangential and axial inclination of the ports. It was found (Fig. 5b), that the maximum value is obtained with a tangential inclination corresponding to 20° and vertical inclination corresponding to 30°.

Also, the discharge coefficient is slightly affected with the increase of the scavenging pressure as shown in Fig. (7).

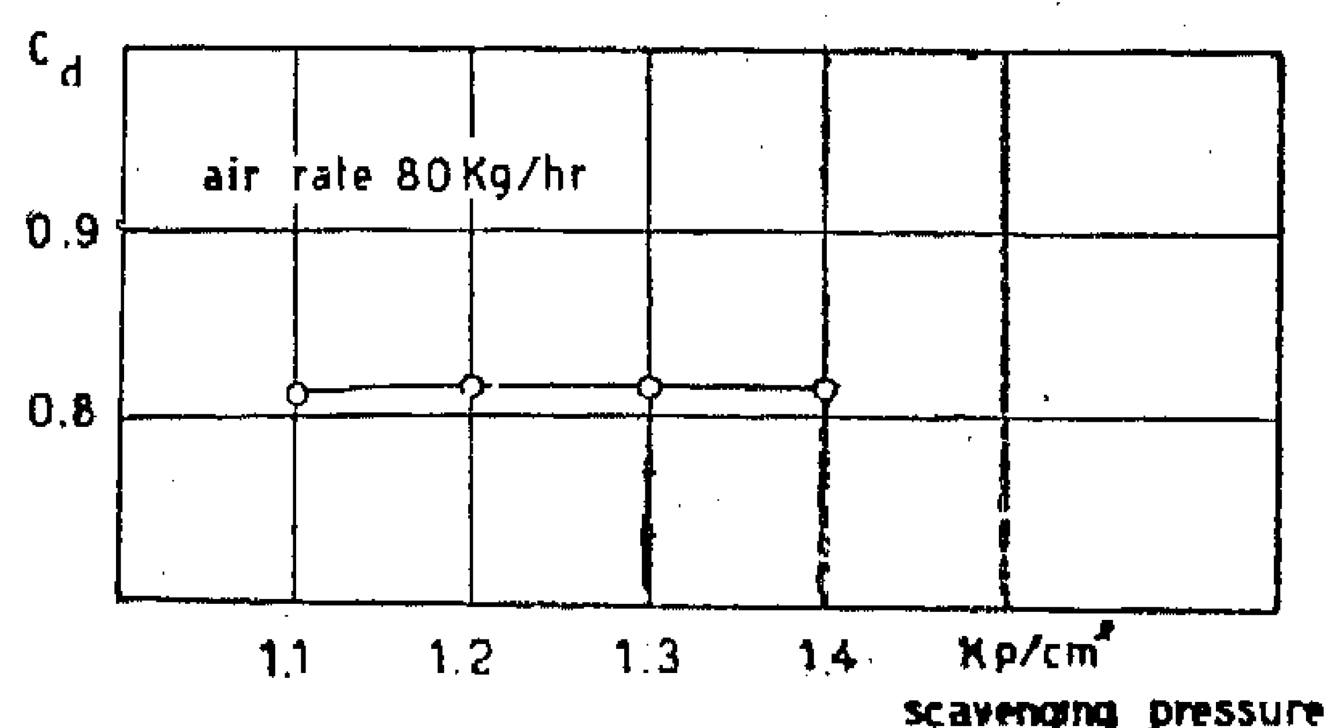


Fig.7 Effect of air pressure on the discharge coefficient.

c) **Determination of the Conservation Coefficient of Moment of Momentum:**

The conservation of moment of momentum can be experimentally determined by determining the tangential velocity pattern inside the cylinder, from which we obtain the moment of momentum of the fresh charge inside the cylinder, and the initial velocity of the entering air to determine the initial moment of momentum.

The tangential velocity pattern was determined by the hot wire anemometer during static scavenging with different port opening and the results are shown in Fig. (8). It was found that the velo-

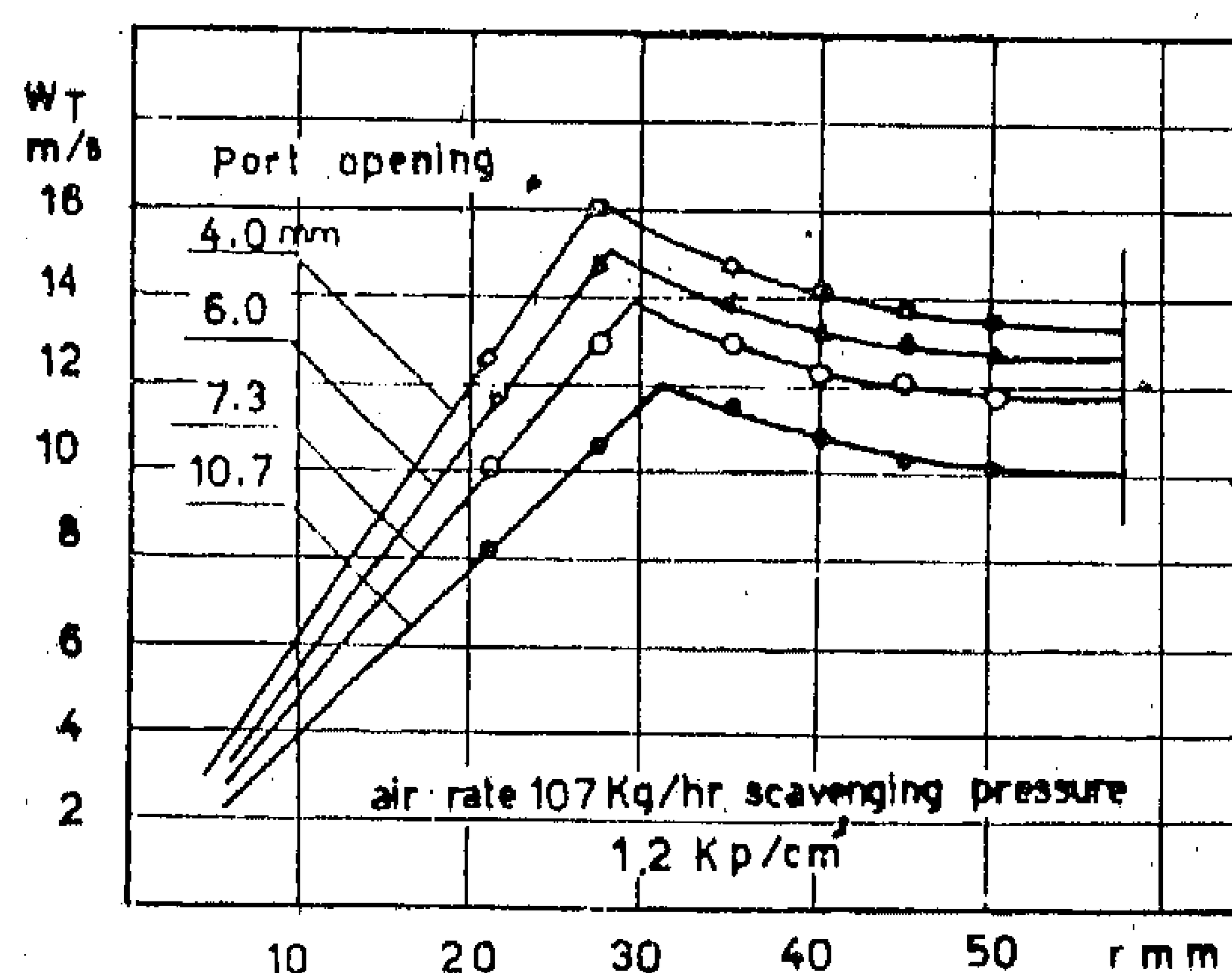


Fig.8 Effect of port opening on the tangential velocity pattern.

city pattern has a specified character which does not change along the cylinder. The experimental values of the conserva-

The cylinder, which is equipped with mechanically operated four exhaust valves and piston controlled air ports, was mounted on a universal crankcase. A variable speed D/C motor was used to drive the model. The scavenging air was supplied by a separate compressor through orifice meter. The orifice meter is connected to a differential mercury manometer to define the actcal mass of air according to the formula :

$$\dot{m}\ \text{actual} = 0.01251\, c_d\, K\ \ d^2 \sqrt{\triangle h}\ \text{kg/hr.}$$

The scavenging ports were arranged in 6 alternatives with different inclination in both the tangential and axial direction as shown in Fig. (4). The combustion chamber was prepared with a special hole

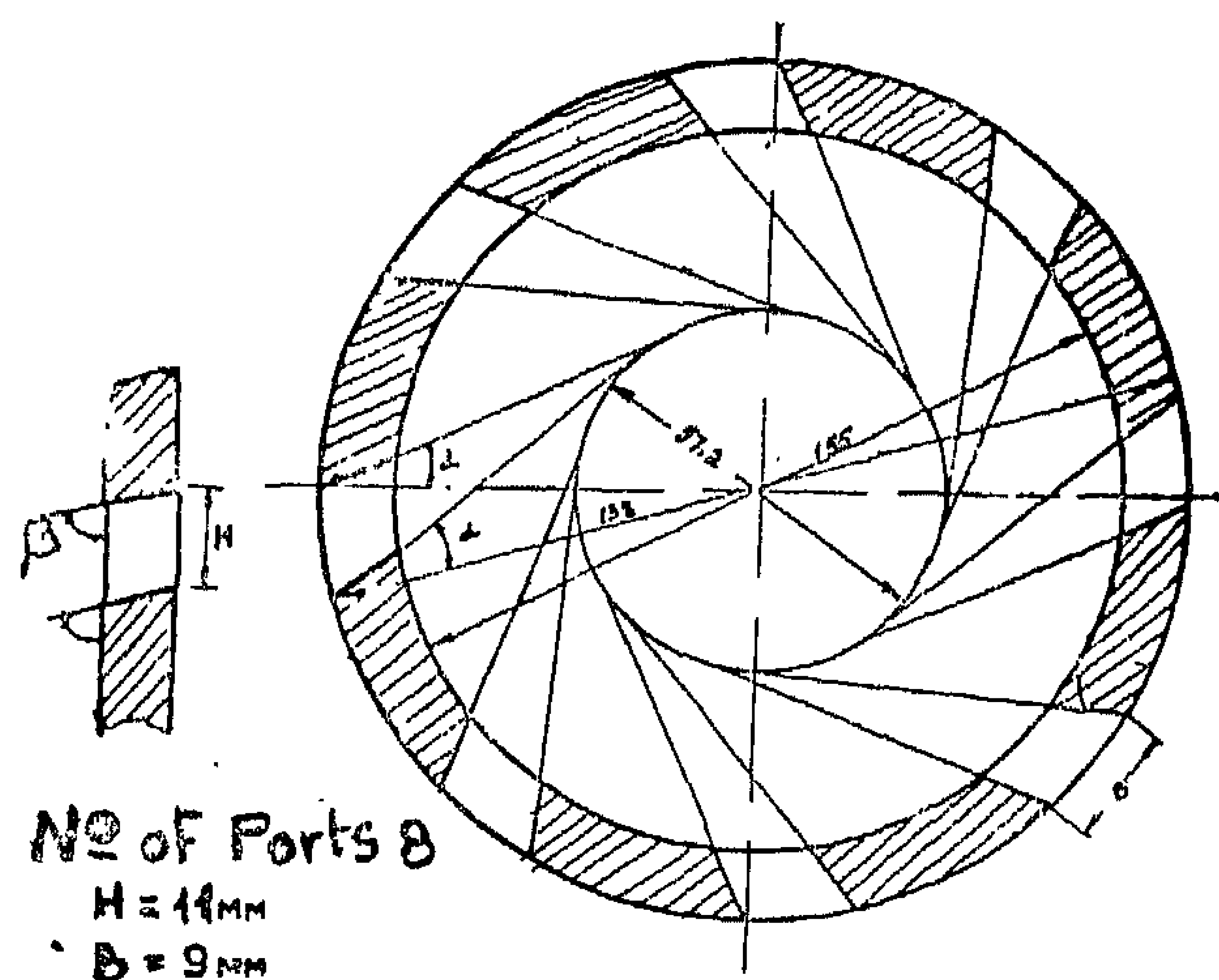


Fig. 4. Cylinder Liner

to hoist the transducer of the hot wire anemometer. The cylinder and cylinder head is heated to the operational condition by a closed glecrin system which is heated by an electrical heater.

The static pressure drop across the scavenging ports together with the scavenging pressure is measured by the differential mercury manometer to determine the theoretical mass rate of air flowing across them according to the formula :

$$\dot{m}_{id} = 0.0158\, A\ \sqrt{\triangle\ h\rho} \qquad \text{kg/hr.}$$

The velocity pattern inside the combustion chamber was determined during static scavenging by the five channel pitot sphere and during dynamic scavenging by the hot wire anemometer fitted with an electronic compensator to registrate the air velocity of a quick variable temperature medium (2). The transducer of the electrothermoanemometer consists of two tungsten wires of diameter 10 μ solded on two nickle legs. One of the wires, which is chosen of small length 4.5 mm and resistance 22.5 Ω to minimize the thermal inertia lag, is used for the registration of the air velocity, pattern, and the other wire of length 18mm., and resistance 56.5 Ω is used for temperature compensation. The construction of the transducer can facilitate longitudinal displacement and rotating motion of the wires around its axis to indicate the air stream direction. The following electronic apparatus are used; measuring bridge, bridge current regulator, amplifier with a feed back compensating system, loop oscillograph MPO-2 for the registration of the galvanometer current. The temperature compensation was checked and a calibration curve was prepared before measuring (1).

b) Determination of the Discharge Coefficient :

The discharge coefficient of the scavenging ports is determined for different port arrangements at different piston positions, different mass rate of flow ranges between 35 kg/hr. and 110 kg/hr and for different scavenging pressures from 1 to 1.6 kp/cm2.

The experimental values of the discharge coefficient for different piston positions and for two alternatives of port arrangements are shown in Fig. (5). It is clear from Fig. (5) that the discharge coefficient increases with the increase of the port opening; it reaches an optimum value and then decreases due to the increase of mass rate of flow. This is sub-

$$\omega = \Gamma / 2\pi R^{n+1}$$

Thus,

$$M_2 = \frac{\Gamma \rho_a S}{3-n} R_c^{3-n} \left(\frac{\varepsilon}{\varepsilon - 1} - \psi \right) \left[(R/R_c)^{3-n} - 1 \right] \quad (7)$$

and the total moment of momentum

$$M_c = M_1 + M_2$$

$$= 1/2\, \pi \rho_a S \omega_c R_c^4 \left(\frac{\varepsilon}{\varepsilon - 1} - \psi \right) \left[1 + \frac{4}{3-n} \left\{ (R/R_c)^{3-n} - 1 \right\} \right] \quad (8)$$

and the conservation coefficient of moment of momentum

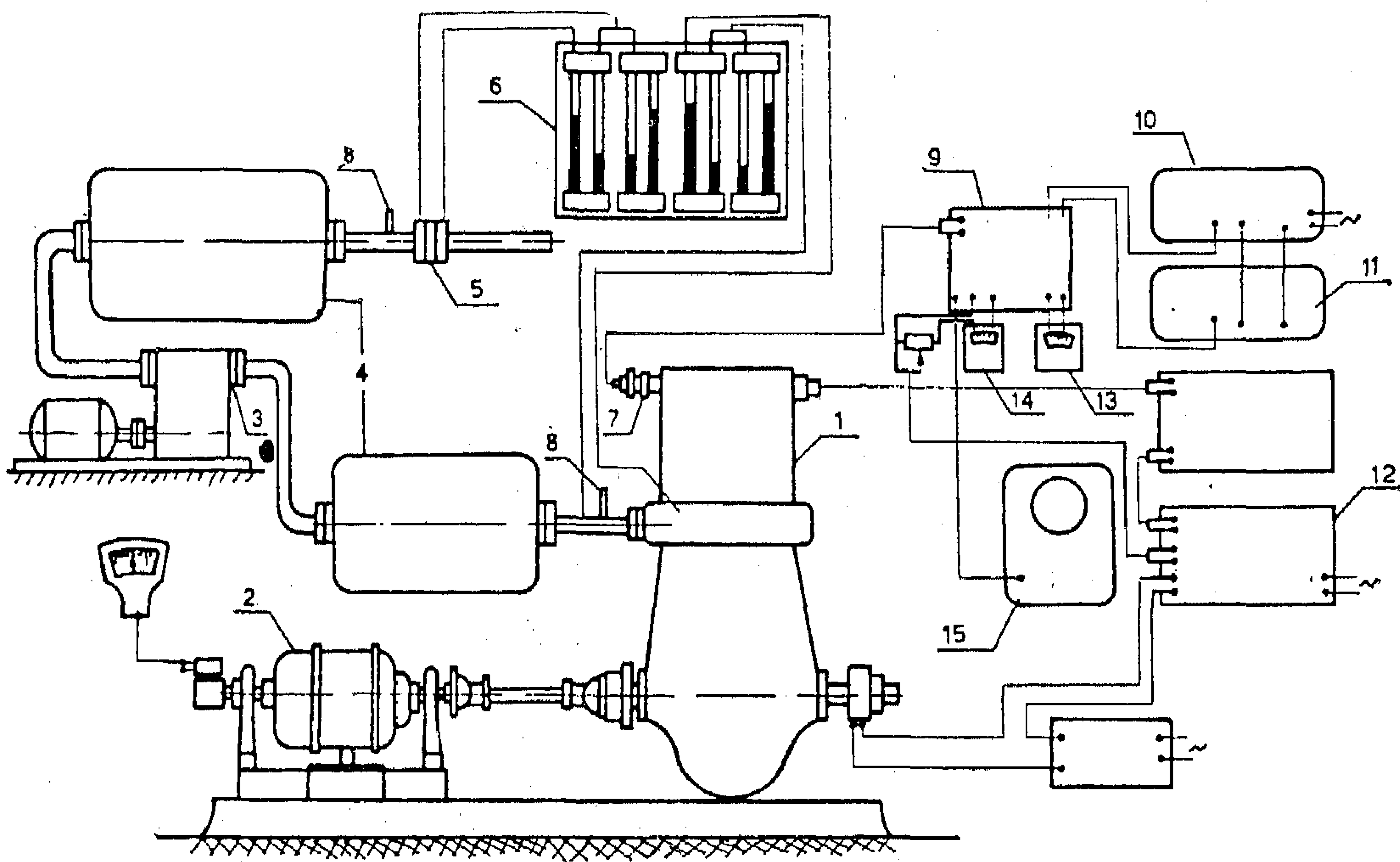
$$\alpha = \frac{1}{2 \sin \gamma} C\, C_v \frac{\rho_a}{\rho_o} \frac{R_c^3}{R^2 R_1} \quad (9)$$

$$\text{where} \quad C = 1 + \frac{4}{3-n} \left[(R/R_c)^{3-n} - 1 \right]$$

Experimental Investigation of Flow Losses :

a) Experimental Plant :

An experimental plant Fig. (3) was built to evaluate the flow losses in the cylinder of a two stroke uniflow scavenging.



(Fig 3) Experimental plant

1-Engine 2-Variable Speed D/C motor 3-Charging compressor 4-Surge tanks 5-Orifice meter 6-Differential manometers 7-Hot wire anemometer 8-Thermocouple 9-Bridge 10-Bridge-current regulator 11-Amplifier 12-Loop oscillograph 13-Galvanometer 14-Ammeter 15-Cathode Ray Oscilloscope

scavenging ports due to flow losses during its motion across the ports, plain jet expansion, collision of plain jets and rearrangement of velocity pattern.

The losses of moment of momentum can be evaluated by the conservation coefficient of moment of momentum :

$$\propto = \frac{M_c}{M_o} \quad \dots \dots \dots \dots \dots \dots \quad (4)$$

The momentum of the fresh charge entering the cylinder :

$$M_o = m\, w_{in}\, R_1 \sin \gamma$$

Knowing that

$$m = \eta_{sc}\, V_s\, \rho_o \quad kg/cycle$$

$$w_{in} = \eta_{sc}\, V_s\, \rho_o \,/\, C_d\, A_{in}\, \rho_a$$

$$w_{in\ id} = w_t\ \omega_c \,/\, C_v$$

$$A_{in} = A \,/\, \omega \quad m^2 sec\,/cycle$$

Thus

$$M_o = \frac{\pi R^2 S \rho_o}{C_v} \left(\frac{\varepsilon}{\varepsilon - 1} - \gamma \right) R_c\ \omega_c\ R_1 \sin \gamma \quad \frac{kg\, m^2}{sec\ \ cycle} \quad (5)$$

The momentum of the fresh charge inside the engine cylinder can be obtained by dividing the cylinder into two region (1)*.

As shown in Fig. (2), the first region where $W_t / R = C$ and the periphery region where $W_t\ R^n = C$.

The moment of the first region

$$M_1 = \int_0^{2\pi}\int_0^{R_c} w_t\, R\, dm$$

Knowing that,

$$dm = R\, dR\, d\theta\, \rho_a\, S \left(\frac{\varepsilon}{\varepsilon - 1} - \gamma \right)$$

$$w_t = \omega_c\, R$$

thus,

$$M_1 = 1/2\, \pi\, \rho_a\, S\, R_c^4\, \omega_c \left(\frac{\varepsilon}{\varepsilon - 1} - \gamma \right) \quad (6)$$

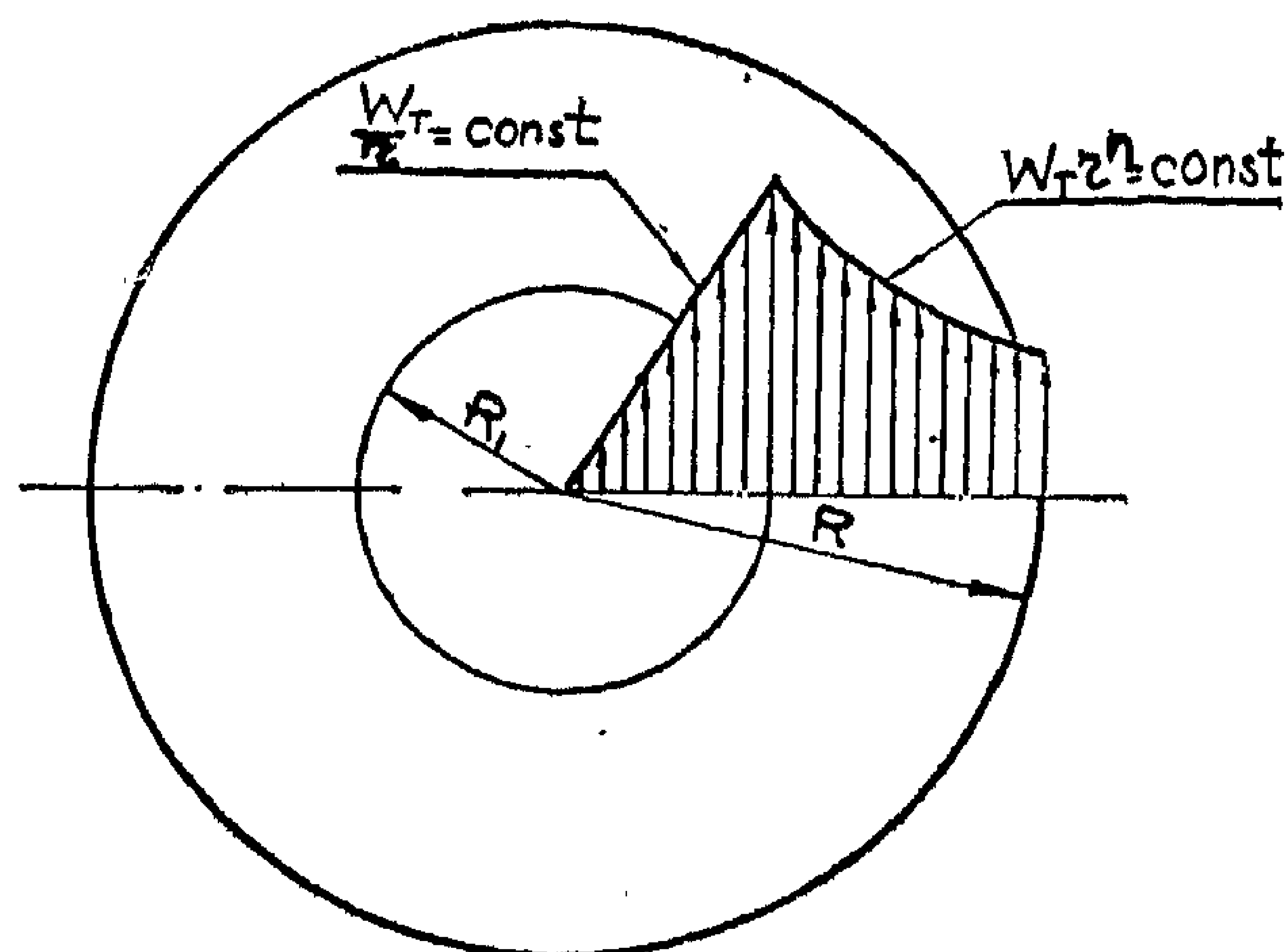


Fig. 2. Tangential Velocity Pattern

The Momentum of the periphery zone

$$dM_2 = dm\ \omega R\ R$$

knowing that,

$$dm = \rho_a\, 2\pi\, R\, dR\, S \left(\frac{\varepsilon}{\varepsilon - 1} - \gamma \right)$$

and the circulation Γ_o for a forced vortex $\Gamma_o = 2\, \Pi\, \omega_c R^2$ and for a flow of a pattern $w_t R^n = C$, it was found experimentally (3) that $\Gamma = \Phi\, \Gamma_o$, where $\Phi = R^{n-1}$ from which we obtain :

* A list of reference is given at the end of the paper.

charge coefficient is equal to the approach velocity coefficient $C_d = C_v$

Integrating equation (1), we obtain :

$$h_{loss} = \int_1^2 dF = \int_2^1 v\,dp + \frac{w_1^2 - w_2^2}{2g} \quad (2)$$

From the momentum balance :

$$[P - (P + dp)]\,A_2 = \rho_2 A_2 w_2' \,dw$$

and the continuity equation :

$$\rho_1 A_1 w_1 = \rho_2 A_2 w_2'$$

and the equation of state for isentropic flow

$$P_1/\rho_1^{\gamma} = P_2/\rho_2^{\gamma}$$

and the discharge coefficient $C_d = \frac{Q_{actual}}{Q_{ideal}}$ we obtain the total loss coefficient for compressible ffow in the following form:

$$K_{loss} = (1 - R)\left[1/C_d^2 - (1 - R)\right] \quad (3)$$

$$\text{where} \quad R = (P_1/P_2)^{1/\gamma} \cdot A_1/A_2$$

Thus, the loss coefficient depends as shown in Fig. (1) on the area ratio, pressure ratio, and the discharge coefficient which can be determined experimentally. The loss coefficient decreases with the increase of the discharge coefficient and it decreases with the increase of the pressure ratio.

A second expression, which is the conservation coefficient of moment of momentum at the end of the compression stroke. The value of the moment of momentum of the fresh charge inside the combustion chamber is smaller than the initial moment of momentum of the entering air from the

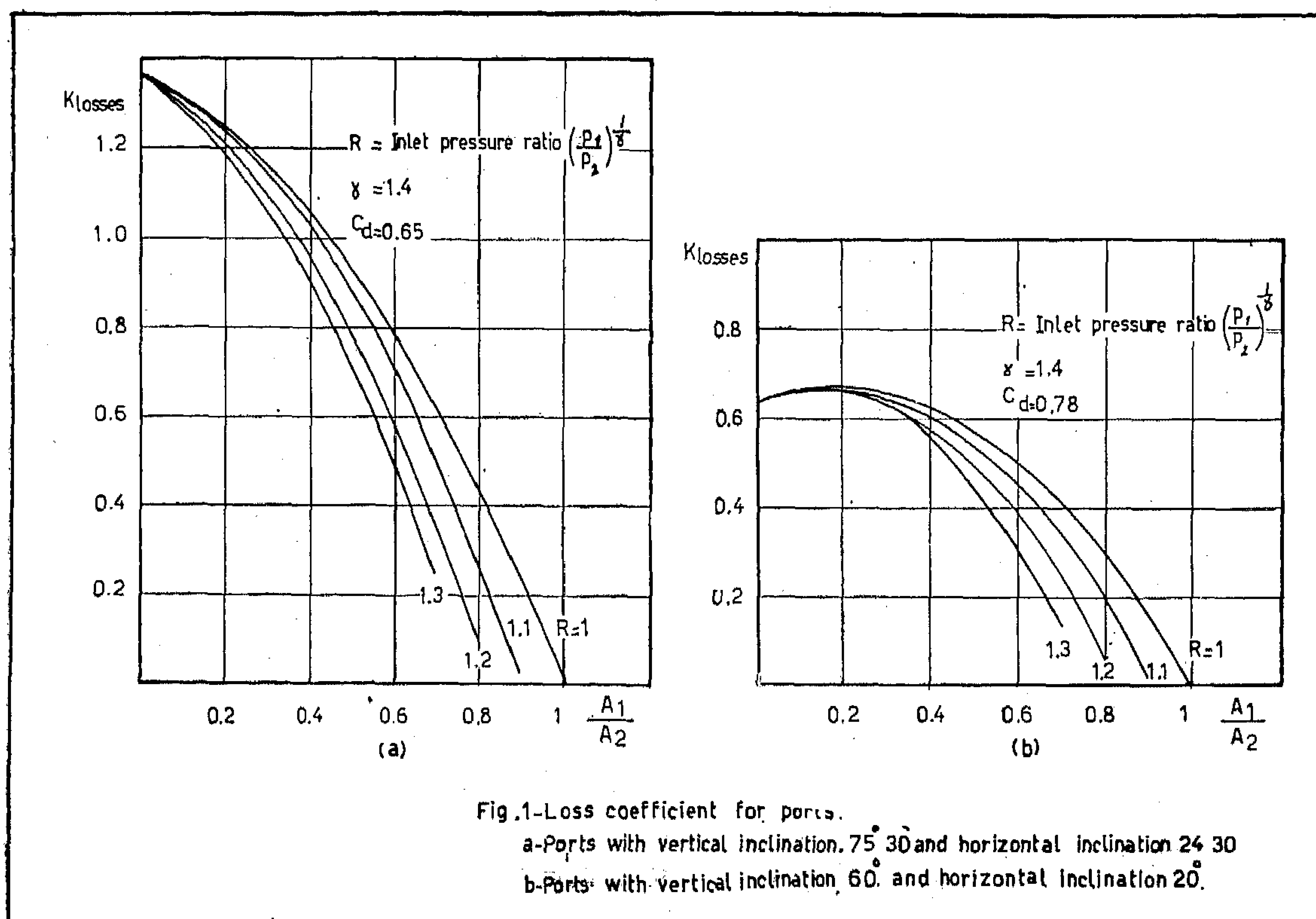


Fig.1-Loss coefficient for ports.
a-Ports with vertical inclination. 75° 30' and horizontal inclination 24 30'
b-Ports with vertical inclination 60° and horizontal inclination 20°.

INTRODUCTION

The economy and power of compression ignition engines depend on several factors among which is the construction of the combustion chamber. The correct organization of the combustion process is the main problem for improving the performance of such engines. In many cases the speed of combustion is defined by the speed of formation of fuel-air mixture. Therefore, the possibility of using the presence air in the combustion chamber to finish the combustion process in a fixed time is defined by the speed of formation of mixture as a result of the molecular and turbulence diffussion of fuel droplets. This depends on the air velocity pattern in combustion chamber.

The increase of hydralic losses, thermal stresses, residual gases and decrease of engine stability of divided combustion chamber may give the open combustion chamber a very important merit. Best paramenters may be obtained in this case on condition that a special attention may be given to the creation of an organized motion of air facilitating high quality of combustion process and no smoke exhaust during the wide variation of working regimes.

The creation of the organized motion of air is accompolished with flow losses. In this paper we are concerned primarily with losses engendered when compressible fluid flow across the tangential ports and cylinder during the scavening and compression strokes.

Also, the study of the gas dynamic condition of the fresh air in the combustion chamber of the two stroke engines was not studied due to the difficult measuring of the air velocity pattern in a high rate of change of pressure and temperature, in addition to the cyclic variation of pressure at the moment of opening of exhaust ports. Therefore, the use of familiar apparatus based on the measuring of total pressure and swirl meters are refused as they can not give accurate results due to inertia and size distribution.

Thus the second point of interest is the tetermination of the air velocity pattern inside the combustion chamber from which the losses of the moment of momentum are deduced. The hot wire anemometer with thermal compensation was used for the determination of the velocity pattern.

Theoretical Investigation of Flow Losses

The main source of hydraulic losses in the scavenging system are the losses initiated from the presence of self generated free mixing stall region before and after the ports resulting from sudden contraction and sudden expansion. This is created due to the separation of the boundary layer from the port edge of the piston crown. Flow losses in such situations are represented by flow loss coefficient, discharge coefficient and loss coefficient of moment of momentum. These losses depend not only on the opening of the ports, i.e. ports area to cylinder area ratio, but on the air pattern inside the cylinder which depends on the construction and distribution of port around the cylinder liner and shape of the piston crown.

The overall loss coefficient for an abrupt contraction and enlargements of a compressible air can be obtained as follows :

From the general energy equation the following relation can be concluded :

$$v\,dp + \frac{w\,dw}{g} + dF = 0 \qquad (1)$$

Also the ideal velocity W'_2 at the outlet is related to the corresponding actual velocity W by the approach velocity coefficient $C_v = W_2/W'_2$, noting that the ports flow full at the outlet, we can assume that the dis-

FLOW LOSSES IN THE CYLINDER OF A UNIFLOW SCAVENGING TWO - STROKE ENGINE

M.M. ELKOTB*, PH. D ENG.

SYNOPSIS

A detailed investigation for the determination of the discharge coefficient and loss coefficient of the scavenging ports and the conservation coefficient of the air moment of momentum and its effect on the velocity pattern inside the combustion chamber is given. Thé investigation includes the effect of port height inclination angles, and engine speed on these coefficients. Formulae are suggested for the calculation of these coefficients, which are required for the prediction of the tangential velocity pattern inside the combustion chamber.

Nomenclature

A : area
c : specific heat
C : coefficient, constant
d : diameter
e : specific internal energy
f : frictional head
g : gravity acceleration
h : fluid head
k : compressibility factor
K : loss coefficient
L : work
P : absolute pressure
Q : external heat transfer, volumetric rate.
R : radius
S : stroke
v : specific volume
V : volume
W : velocity
Z : potential head
m : mass
M : moment of momentum
n : exponent.

$\propto$: conservation coefficient of moment of momentum
β : Vertical inclination angle.
γ : isentropic index, vertical inclination angle.
Γ : circulation
ε : compression ratio
$\eta_{b_{sc}}$: scavenging efficiency.
$d\Theta$: angular element
ψ : stroke loss
ω : angular velocity
ϱ : density

: Subssccripts

id : ideal
in : inlet
0,1,2 : stations
a : air charge
c : cycle
d : discharge
o : initial
s : stroke
t : tangential.

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INDUSTRY & PRODUCTION

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شركة النصر العامة للمقاولات

« حسن محمد علام »

كبرى شركات التشييد والبناء بجمهوريتنا

- تسهم بكل طاقاتها وامكانياتها فى تشييد وبناء أهم المشروعات المصرية والعربية .
- تعتبر الشركة انطلاقة كبرى فى داخل وخارج حدود جمهوريتنا .
- أولى الشركات العربية السباقة فى الانفتاح الاقتصادى وتدعيم اقتصادنا القومى بجلائل أعمالها فى الخارج وجلب العملات الصعبة للبلاد .
- تقف وراء النهضة الصناعية والعمرانية من أجل رفاهية الشعوب العربية وعزة الانسانية العربى ... وحماية الوطن العربى .
- **تتمتع أعمالها بسمعة طيبة وكفاءة ممتازة خارج جمهوريتنا ففى :**

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العراق : تقوم بتنفيذ مستشفى البصرة على على احدث طراز

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بلجراد : بشيكوسلوفاكيا

علاوة على أعمال الشركة فى جمهوريتنا فهى بصدد تنفيذ عمليات اخرى بمدينة بلجراد بتشيكوسلوفاكيا

حلوان :

وعقد ب ١٥ مليون جنيه

كما اسند للشركة اعمال ب ١٥ مليون جنيه فى مجمع مشروع الحديد والصلب عبارة عن حجم ب اعمال ٧ مليون جنيه متر مكعب قطع ونقل وتسوية مواقع الفوسفات وانشاء جسور السكك الحديدية ٦٠٠ الف متر مربع ورصف ، ٢٣٠ **الف متر مكعب** خرسانة عادية ومسلحة ، ٤٢ الف متر مكعب مبانى ، ٤ الاف طن اعمال حديدية مسقولة وليس أدل من هذه الأرقام على ضخامة وعبء المسئولية التى تحملها شركة النصر العامة للمقاولات « حسن محمد علام » ورئيس ادارتها حسن محمد علام والمهندسين والعمال عندما نزلت أول صبه من الحديد والصلب المنصهر من الفرن الثالث العالى .

وبعد .. أن بيان جلائل الأعمال التى تقوم بها شركة النصر للمقاولات « حسن محمد علام » فهى الواجهة المضيئة لغد مشرق وعلى امتداد ارضنا الطيبة تقف شركة النصر العامة للمقاولات ثم تمتد مشروعاتها بخبراتها المصرية الى البلاد العربية ليبيا العراق — الكويت — تشيكوسلوفاكيا .

والى الكثير من البلاد العربية لتثبت كفائتها بايمانها الكامل بالعمل من أجل رفاهية الشعوب من أجل بناء حياة الانسان فى كل مكان .

المركز الرئيسى : القاهرة ٧ شارع عبد الخالق ثروت تليفون ٧٠١٥٣/٦/٥/٤

الاسكندرية : ١٥ ميدان سعد زغلول ت ٢٥٥٦١

الكويت : عمارة الخالد / شارع فهد السالم ت ٣٥١٩٥ — ٣٥١٢٤

العراق : عمارة كبة / شارع السعدون — بغداد ت ٨٩١٧١

ليبيا : طرابلس : شارع النصر .. عمارة البدرى ت ٣٢٩٢٤

بنغازى : شارع عمر المختار ت ٤٤٠٤

الشركة العربية لأنابيب البترول



إحدى ثمار حرب أكتوبر العظيم .. والتضامن العربي الكبير

لم تكن حرب السادس من اكتوبر ، هى مجرد عبور القناة ، وتحطيم خط بارليف ودحر العدو ولم تكن هى مجرد تحرير الأرض . لقد كانت تحرير الانسان فى البداية . تحرير الانسان العربى ، ووضعه موضع المسئولية أمام مقدراته كانت حرب السادس من أكتوبر هى التحدى الحقيقى ليثبت الانسان العربى وجوده تحت الشمس . ليثبت انه جدير بوجوده ولقد استطاع الانسان العربى أن يثبت ذلك ، بتلك الوقفة الشجاعة ، والمصممة .. التى جعلت كبرى الدول ، تقف مذهولة أمام ذلك التجمع العربى . وكان لابد أن يتجاوز الانسان العربى حكومات وشعوبا تلك المرحلة الى مراحل أخرى ، أبدع وأعظم أن يعمل على تنمية موارده واستغلال طاقاته . التى كانت مكدسة فى البنوك الأجنبية . كان لابد أن تستثمر الأموال العربية لحساب الشعب العربى ، وابراز الدور المهم الذى يجب أن يلعبه راس المال العربى فى تنمية موارد الأمة العربية . واثبت الانسان العربى ذلك ، عن طريق تأسيس أول شركة عربية لنقل البترول بواسطة خطوط الأنابيب بين السويس والاسكندرية .. تحت اسم **الشركة العربية لأنابيب البترول « سوميد »** . ورأس مال الشركة العربية لأنابيب البترول ٤٠٠ مليون دولار يخص جمهورية مصر العربية ٢٠٠ مليون دولار ويخص كل من المملكة العربية السعودية والكويت وأبى ظبى ٦٠ مليون دولار ويخص دولة قطر ٢٠ مليون دولار . ومن المعروف أن هذه الشركة الجديدة ستقوم بانشاء خطوط أنابيب لنقل البترول من خليج السويس الى البحر الأبيض المتوسط ... بالاضافة الى تشغيل هذه الخطوط فضلا عن القيام بجميع الأعمال الفنية والصناعية والتجارية المتعلقة بهذا النشاط والمكملة له . وقد مثلت الشركة العربية لأنابيب البترول .. الصيغة الملائمة للتعاون الاقتصادى البناء والمثمر بين الدول العربية .. اذ تؤدى الشركة خدمات الدول المنتجة للبترول فى الخليج العربى والجزيرة العربية وذلك بنقل البترول الى أماكن استهلاكية عن أقصر طريق ، وبأقل النفقات .

وأخيرا .. أجتمع العرب على كلمة رجل واحد ... وشهدت القاهرة مشهدا عظيما حينما اجتمع ممثلوا الدول المشتركة . لتوقيع عقد الاتفاق ، بقيام **الشركة العربية لأنابيب البترول** .. كأول شركة مساهمة عربية .

تقوم برأس مال عربى .. وهكذا أثبتت حرب أكتوبر المجيدة ، قدرة الانسان العربى وتملكه لمصيره ، ومقدراته من أجل صالح الشعب العربى .. أو كما عبر **المهندس عز الدين هلال** وزير البترول فى كلمته حين قال : لقد حملت معى أثناء رحلاتى السابقة للأمة العربية مجموعة من الرسائل من **الرئيس أنور السادات** الى الملوك والرؤساء العرب بخصوص هذا الموضوع ، وكان رد الملوك والحكام رائعا فى حد ذاته . لقد قالوا ان ما يريده الرئيس السادات سوف ينفذ بالكامل .

وهكذا ... **قامت الشركة العربية لأنابيب البترول** ..

الزيارة الثالثة لوزير الصناعة والثروة المعدنية .. لـ

مجمع الألمونيوم ... بنجع حمادى

- فى عيد إنتصار أكتوبر .. يبدأ الإنتاج .. فى المجمع
- وزير الصناعة يقول : العمل فى المجمع يزيد إيماننا بالصناعة ومستقبلها
- ٣٦ مليون جنيه إسترلينى .. قيمة الإنتاج السنوى للمجمع



المهندس ابراهيم سالم محمدين وزير الصناعة والثروة المعدنية ... مهندسو المجمع وكبار الزوار والمستقبلين اثناء تفقدهم بعض المنشآت بالمجمع

فى كلمات مشرقة قال **المهندس ابراهيم سالم محمدين** وزير الصناعة والثروة المعدنية معبرا عن صورة العمل الكبير الذى يجرى الآن فى بناء مجمع الألومنيوم بنجع حمادى قال : أن ما يجرى الآن فى هذا المكان من أرض مصر يجب أن يزيد من ايماننا بالصناعة .. وما يمكن أن تؤديه من تغيير فى المجتمع المصرى كله أن الجهد الخلاق الذى تقدمه .. الأيدى المصرية التى تعمل هنا .. فى هذا المكان لا يقدم لنا مصنعا كبيرا فقط لكنه فى الواقع يقدم لنا مجتمعا كاملا يساهم فى زيادة الدخل القومى بعشرات الملايين من الجنيهات كما انه يربى الكوادر الفنية لصناعة جديدة معقدة .. تساهم بدورها فى صنع المستقبل .. مستقبل مصر الصناعى المشرق ...

جولة فى مدينة الالمنيوم :

وقد قام **المهندس ابراهيم سالم محمدين** وزير الصناعة والثروة المعدنية بجولة واسعة لمجمع الالمنيوم شملت ميناء سفاجة على البحر الأحمر وشملت الزيارة الميناء النهرى بنجع حمادى وهو الميناء الذى استخدم خلال الفترة الماضية فى نقل الآلات ومعدات المجمع التى تزيد عن ١٠٠ ألف طن تم توريدها بالكامل بالاتفاق مع الاتحاد السوفيتى .. ويجرى الآن تركيبها تمهيدا لبدء الانتاج بالمجمع. كذلك استقبل الميناء عشرات الألوف من أطنان الحديد والاسمنت والهياكل المعدنية ومواد البناء اللازمة للمجمع .

صورة مشرفة للعمل

وفى خلال هذه الزيارة وافق الوزير السيد **محمود زكى عبد اللطيف محافظ قنا والمهندس / مرعى أحمد مرعى** رئيس مجلس ادارة المؤسسة المصرية العامة للصناعات الكيماوية .. وبعض كبار رجال الصناعة وقد قدم **الدكتور مهندس يوسف اسماعيل محمد** ، مفوض المجمع صورة كاملة لكل المراحل التى تم انجازها خلال الفترة فى وقت قياسى ..

عصر الالمنيوم

ومن المقرر أن يبدأ تشغيل المجمع بثلث طاقته الانتاجية أثناء عيد النصر الأول فى أكتوبر القادم كمرحلة أولى يليها تشغيله بثلثى الطاقة الانتاجية بحيث يتم الوصول بطاقته الانتاجية الكاملة وهى مائة الف طن سنويا فى العيد الثالث والعشرين لثورة يوليو ....

وكما اكتسب المجمع قيمة ضخمة من حيث تنفيذه فى ظروف المعركة فان له قيمة اقتصادية كبرى تتمثل فى قيمة الانتاج الذى يحققه سنويا .. كذلك الوفر فى العملات الأجنبية التى تدعم ميزان مصر التجارى كما يوفر فرص العمالة أمام الألوف من أبناء المنطقة .

توسيعات فى المجمع

وكان من الطبيعى أيضا وقد صاحب هذا المشروع النجاح منذ البداية نتيجة التخطيط العلمى الحديث أن يجرى التفكير فى مشروعات المستقبل .. مشروعات التوسع فى الانتاج يستهدف زيادة الطاقة الانتاجية للمجمع من ١٠٠ الف طن الى ١٦٦ الف طن فى السنة ..... وسيكون هذا المشروع موضوع الاتفاق خلال الزيارة التى يقوم بها **المهندس ابراهيم سالم محمدين** وزير الصناعة والتعدين والوفد الصناعى المرافق له الى موسكو فى أوائل يوليو القادم ...

تقدير العاملين

وتقديرا لهذا الجهد الكبير فى بناء مجمع الالمنيوم وافق وزير الصناعة على صرف مكافأة لجميع العاملين بالمجمع تعادل لأجر شهر تقديرا لما بذلوه فى الفترة الماضية ..

الواقع ان هذا التقدير .. هو تقدير لجهود خلاقة مثمرة غيرت وجه الحياة فى المنطقة واقامت مجتمعا جديدا ... وتدعمه صناعة ثقيلة عملاقة .. هى صناعة الالمنيوم .. وفى أكتوبر القادم تدور عجلة العمل ... وتدخل صناعة بلدنا عصراً جديدا .. ومرحلة يتردد فيها اسم نجع حمادى فى أسواق الالمنيوم فى العالم كله ...

اشتراكات الجمعية :

	قرشا
العضو	٢٠٠
العضو المنتسب	١٥٠
المنتسب	١٠٠

اشتراكات المجلة :

يتلقى أعضاء الجمعية نسخهم مجانا .

ولغير الأعضاء :	قرشا
الاشتراك السنوى للمهندسين	١٠٠
الاشتراك السنوى لغير المهندسين	٣٠٠
الاشتراك السنوى للهيئات	٥٠٠

تعطى أولوية النشر بالمجلة للسادة
الزملاء اعضاء جمعية المهندسين المصرية

شركة النيل العامة للإنشاء والرصف

إحدى شركات المؤسسة المصرية العامة للطرق والكبارى

القاهرة : ٣٢ شارع الفلكى تليفون : ٢٥٦٦١ - ٢٤٦٢٥ القاهرة



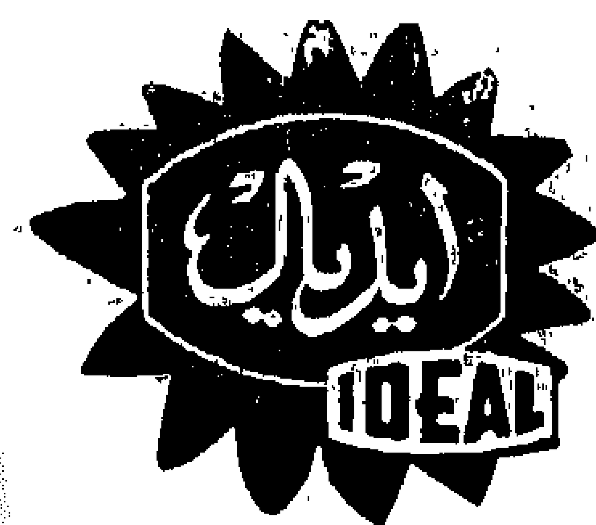
أهم المشروعات التى قامت الشركة بتنفيذها :

خارج جمهورية مصر العربية

- طريق جمهورية مالى .
- طرق ومطارات الجمهورية العربية اليمنية

داخل جمهورية مصر العربية

- الطريق الساحلى على البحر الأحمر
- أجزاء الطريق الصحراوى مرسى مطروح - السلوم
- أجزاء الطريق الرئيسى بالوجه البحرى
- تقويات للطرق الرئيسية بالجمهورية
- مطارات حربية ومدنية





سعادة أسرتك
تحقق بمنتجات
ايديال
المتطورة

- حجرات سفرة حديثة
- حجرات نوم رائعة
- أثاثات معدنية كاملة للمكاتب والمنازل والحدائق

شركة النصر لصناعة المطروقات

احدى شركات المؤسسة المصرية العامة للصناعات المعدنية

NASR. FORGING INDUSTRY

TAREK

MOTOR-CAR PARTS

CRANK SHAFTS

MOTOR-CAR PARTS

CHAINS & SHACKLES

EXPORT PRODUCTS

HAND TOOLS

العدد اليدوية

HAND TOOLS

مطروقات



RAILWAYS PARTS

تستخدم منتجات الشركة في الصناعات الآتية :

- السيارات والجرارات ومحركات الديزل
- الدراجات والموتوسيكلات .
- معدات السكك الحديدية .
- العدد اليدوية والزراعية وأدوات الطرق وآلات الورش
- بنسوس وملحقاتها مقاسات من ١٦ - ٤٠ مم
- للمنشآت البترول
- تشكيل الأحجام الكبيرة من الأعمدة والتروس من الصلب المطروق حتى ٨٠٠ كجم للقطعة الواحدة .
- انتاج الاسطمبات اللازمة لمختلف الأغراض
- طلبات السوق المحلي .
- كما تفخر الشركة بتصدير كثير من منتجاتها الى الدول الأوربية مثل الكرنكات والعدد اليدوية وأجهزة ...
- وقد شاركت الشركة في كثير من المشروعات الصناعية الهامة والتي تتمثل حاليا في مشروع كهربة الريف

صناعات عربية ومواصفات عالمية تشق طريقها الى جميع الأسواق العالمية

الإدارة والمصانع : التبين ، حلوان . ص . ب ١٥ . تلغرافيا : مطروقات تليفون ٣٩١٤٧ / ٣٩١٤٩

المدير التجاري تليفون ٣٩٧٩٨ مكتب القاهرة / ١٨ شارع عماد الدين تليفون ٧٨٥٥٤

Arab Company for Petrolium Pipes (SUMED)

(A fruit of October great WAR and great Arab solidarity)



Six October War was not a mere crossing of the canal, it was not also a mere distruction of Parlief Line, not even a mere liberation, of the occupied territories but it was a complete power of the Arab People to face the enemy with their responsibilities towards the great abilities of the Arab Nation.

October was the true challenge for the Arabs to prove their existance as an effective Nation. This was reached by the gathering of the brave Arabs, the determined leap of October causing this amazement even to the greatest countries.

It was avoidable for the Arabs, for the Government and for the Communities to develop their resources and use their capitals in the Foreign Banks for the welfare of the Arab People. The most important point is that the capital of the Arabs Nation could improve now by creating the first Trab Company to communicate petroleum through pipes between Suez and Alexandria under the name "ARAB COMPANY FOR PETROLEUM PIPES".

The Capital of this Company is as follows

400 Million Dollars concerns Misr Arab Republic

200 Million Dollars concerns Saudi Arabia, Kuwait and Abu Dabbi

20 Million Dollars concerns Kattar Republic.

This Company will be responsible to build up petroleum pipes from Suez Gulf to the Mediterranean Sea. The Company is going to use these Pipes and will be responsible for all the technological, industrial and commercial activities.

This Company is an ideal specimen for the economical co-operation between the Arab Countries. The Company will be of great help for all the countries around the Arab Gulf, and the Arab Island, by transmitting the Petroleum production quickly and at minimum cost to the consumers.

At last the Arabs gathered and acted as one man. It was a heart plesant scene in Cairo, when the delegations of the contributing countries signed the agreement contract for the foundation of the Arab Company for Petroleum Pipe as a First Company supplied by the Arab Capital.

Thus October WAR proved the capability of the Arab People to decide their destiny and master their resources for the benefit of the Arab Nation. This meaning was stressed by the Engineer Izz el Dine Hilal, Petroleum Minister, when he said, "During my last travel I carried many letters from President EL Sadat and the Arab Presidents and Kings concerning the Company. Their reply in itself was magnificent, President Sadat words will be executed in full".

"Thus the Company for Petroleum Pipes is created".

الخامات الأولية
والصناعات الكيميائية

جمعية مهندسى المناجم والبترول
والفلزات
جمعية المهندسين الكيميائيين

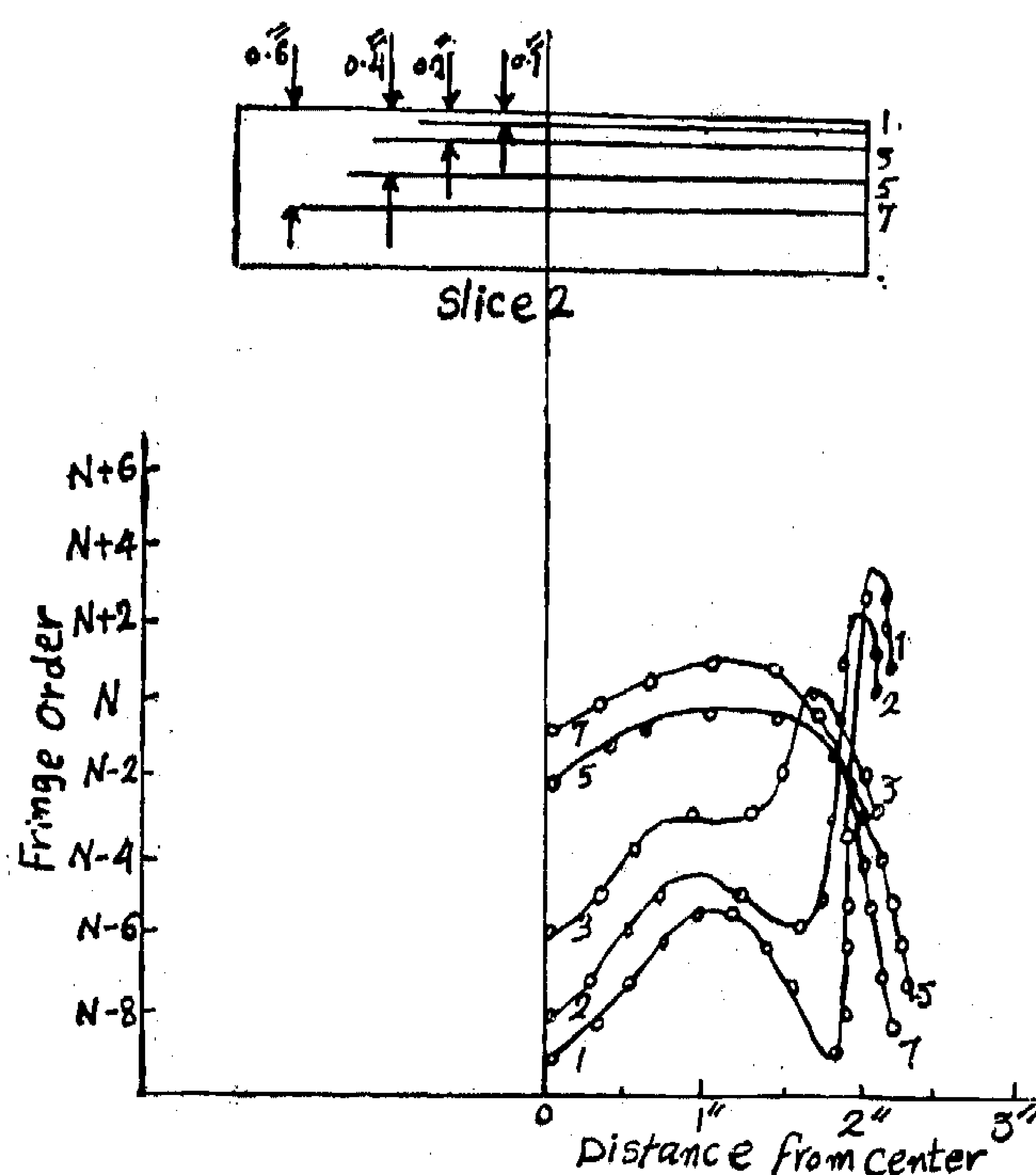


Fig. 6. Stress distribution in ln slice 2 of square Model

stress peak decreases in intensity while the inside peak rises and spreads wider until the outside peak vanishes completelg leaving the inside peak alone.

6. The optical effects observed in a slice very close to the edge of a circular model could not be interpreted.

BIBLIOGRAPHY

1. Coker E. G. and Filon L. N. G., A Treatise on Photoelasticity (2nd Ed.), Cambridge University Press, London, 1957.

2. Duaval W. I., Stress Analysis Applied to Multiple Opennings and Pillars, Report of Investigations, 4387, USBM, 1948.

3. Roy, Mayers, and Dachile, Review of Scientific Instrument, vol. 34, 1963, p. 401.

4. Lippincott and Duecker, Pressure Distribution Measurements in Fixed Anvil High Pressure Cells, Science, vol. 144 No. 3622, May 1964, p. 1119-1121.

EXPERIMENTAL DATA

	Circular Model :	Square Model :
weight of Araldite	344.40 gm	253.60 gm
weight of Hardner	38.26 gm	28.17 gm
weight of Thinner	270.30 gm	70.44 gm
room temprature	70 F	70°F
time for semi-cure	12 hrs	14 hrs
load for 8 hrs	15 000 lbs	2 500 lbs
model dimension:		
diameter	6"	4"x4" cross-sec.
height	0.883"	1"
thickness of slices	0.121"	0.17"

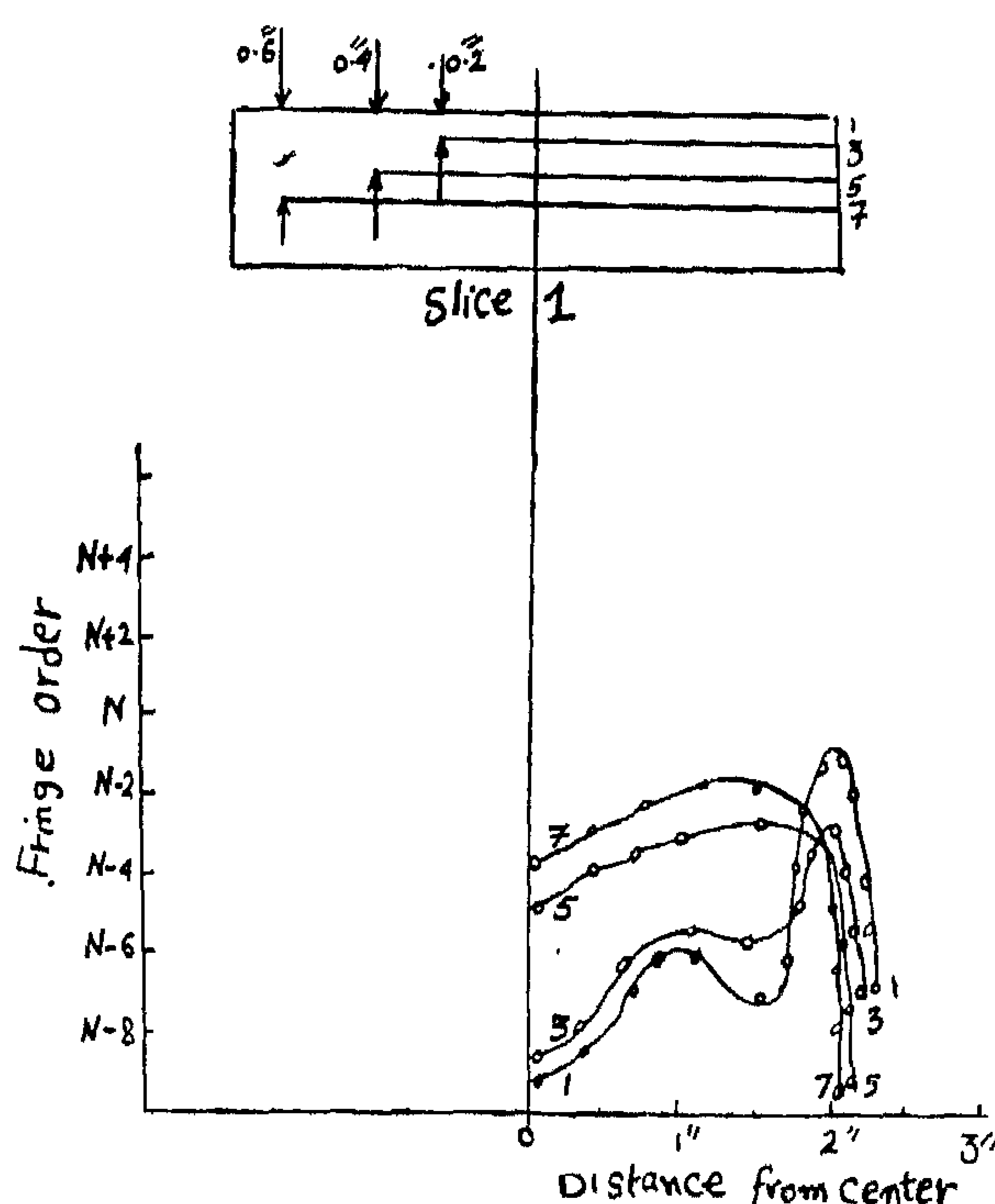


Fig. 5. Stress distribution in slice 1 of square Model

CONCLUSIONS

The following are the conclusions based on the present study on short pillars:

1. The stress distribution in short pillars is not as simple as that observed in the two-dimensional photoelastic study performed by previous investigators.

2. Stress distribution across the top of the pillar (the surface in contact with the loading surface) is different from that which exists across a horizontal line below the top surface. The nature of distribution varies from line to line in the same pillar.

3. In all the models studied it is seen that the maximum stress occurs at the edge only in the case of stress distribution along the pillar top. Even in such cases, there exists a "low" very close to the edge. There is a secondary maximum in the stress distribution which agrees with the conclusion arrived at by Coker and Filon by their mathematical analysis of stress in case of a cylindrical block.

4. Across all other lines below the top loading surface, the stress distribution shows a minimum at the edge, followed by a major peak close to it towards the center. The occurrence of a secondary peak or maximum in a stress distribution along a line depends on the position of the line from the top.

5. Leaving the pillar top and going down, it is obsrved that the outside

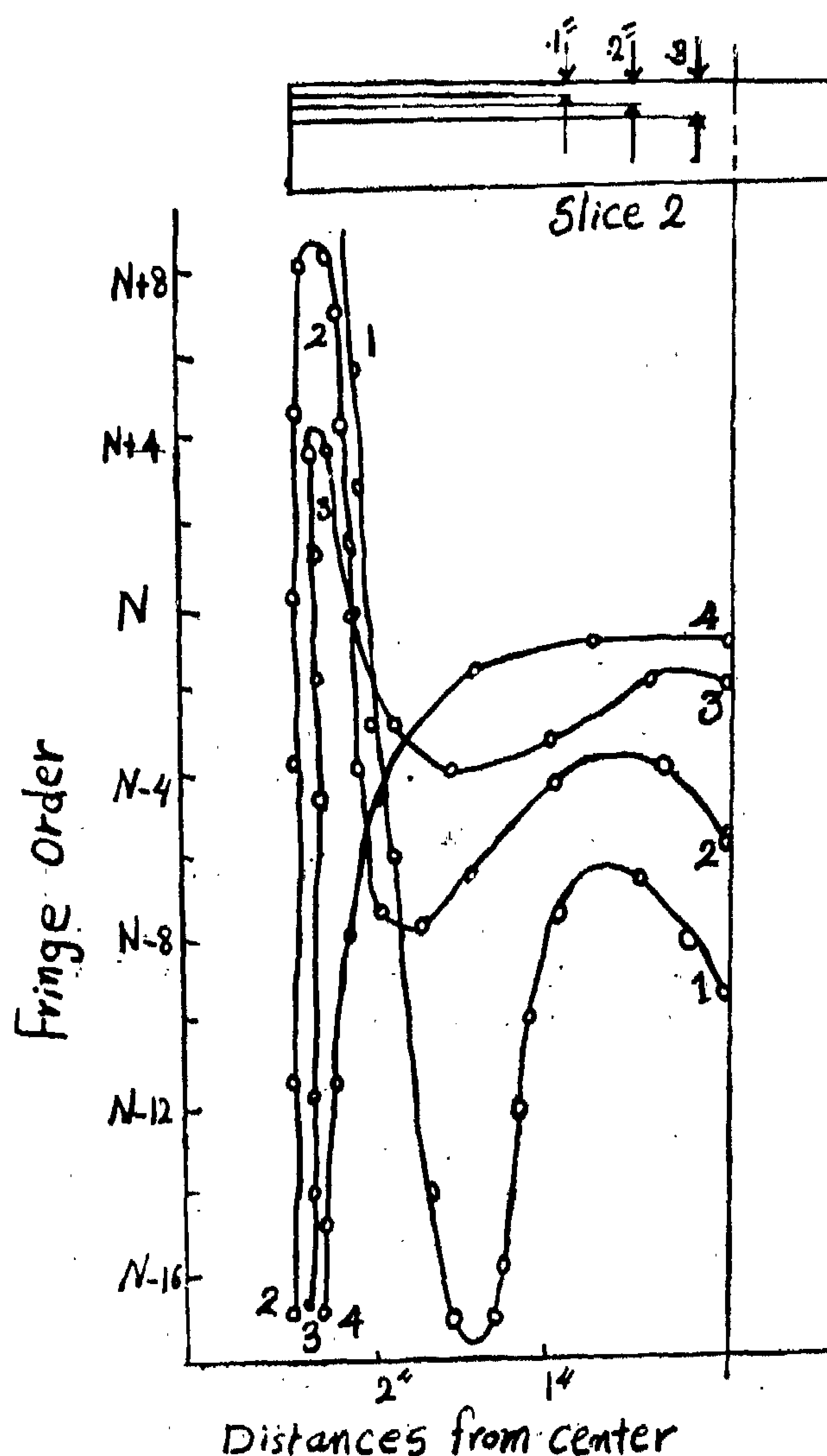


Fig. 3. Stress distribution in slice 2 of circular Model

EXPERIMENTAL PROCEDURE

Precooled Araldite 502, Hardner 951, and Dybutyl Pthalate (Thinner) were mixed in the proportion 72:8:20 respectively. The mixture was poured into a 6"diameter and a 4"x4" molds. The mixture was allowed to cure for 12 hours and then released from the molds. The end faces were surfaced and the model was pressed under constant pressure for 13 hours or more in a hydraulic testing machine. The models were sliced along planes parallel to the directions of the load. Figures 1 and 4 show the locations of the tested slices in the models.

The "locked-in" stresses in the slices were optically analyzed in a standard circular polariscope.

Relative fringe order at different points along horizontal lines across the slices were determined. Since the fringe order is proportional to the shear stress, the curves obtained by plotting the fringe order versus the distances of the points from the center of the model represent the shear stress distribution along a line. Such curve are given in figures 2,3,5 and 6 for one half of the model. The stress distribution for the other half is a miror image.

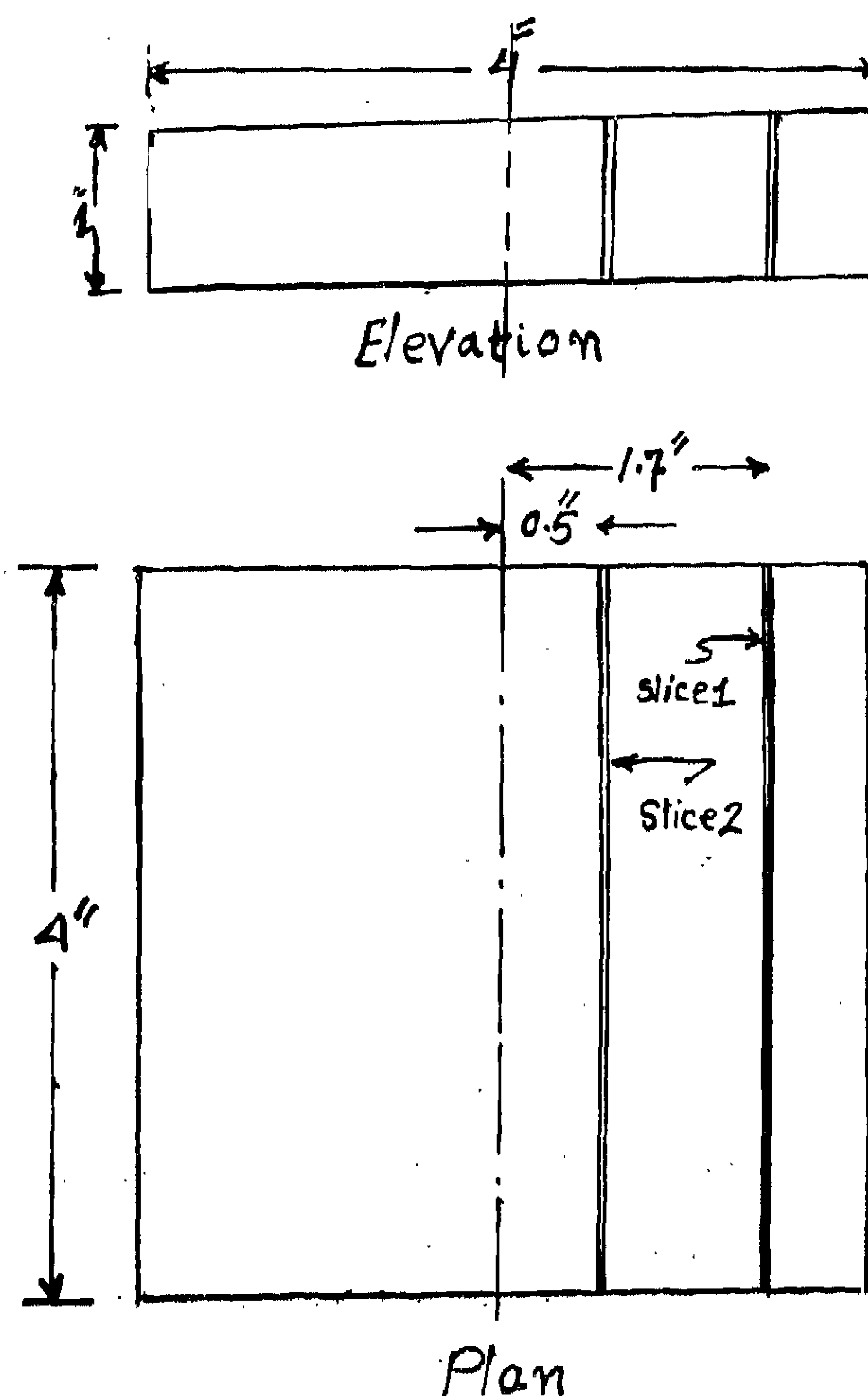


Fig. 4. Square Model showing the locations of slices

SHORT COLUMNS

For the purpose of compression tests, the American Society of Testing Materials, has divided columns into three categories: 1) short, the height of which is 0.9 of its diameter, 2) medium, with height equals three times the diameter, 3) long, when the height is 8 to 10 times the diameter.

Coker and Fillon[1] have stated that in short columns or blocks under compression, "the manner in which the load is applied to the end faces" exerts an influence on the distribution of stress and strain. They have confirmed these end effects by measurements which show that compressive stress is reduced "at the center of the end faces".

Duaval[2] carried out tests on two-dimensional photoelastic models for holes of different geometric shapes. He concluded that the stress concentration takes place at the skin of the pillar.

Roy[3] worked on high pressure cells. He determined the location (distances from the center of a disk) of a known phase transition of Bi(I-II) at 25.4 kg pressure as a function of the applied pressure. He found a "pressure multiplication" effect in which the stress observed in the center of the high pressure cells was about 2 to 2.5 times the average applied pressure and the stress at the edges was nearly equal to or slightly less than the average applied pressure.

Lippincott and Duecker[4] reported that measurements of pressure distribution in transparent high-presscre cells was possible by using pressure senstive materials and these measurements produced a parabolic stress distribution in which which the magnitude of stress was maximum at the center, and zero at the edges.

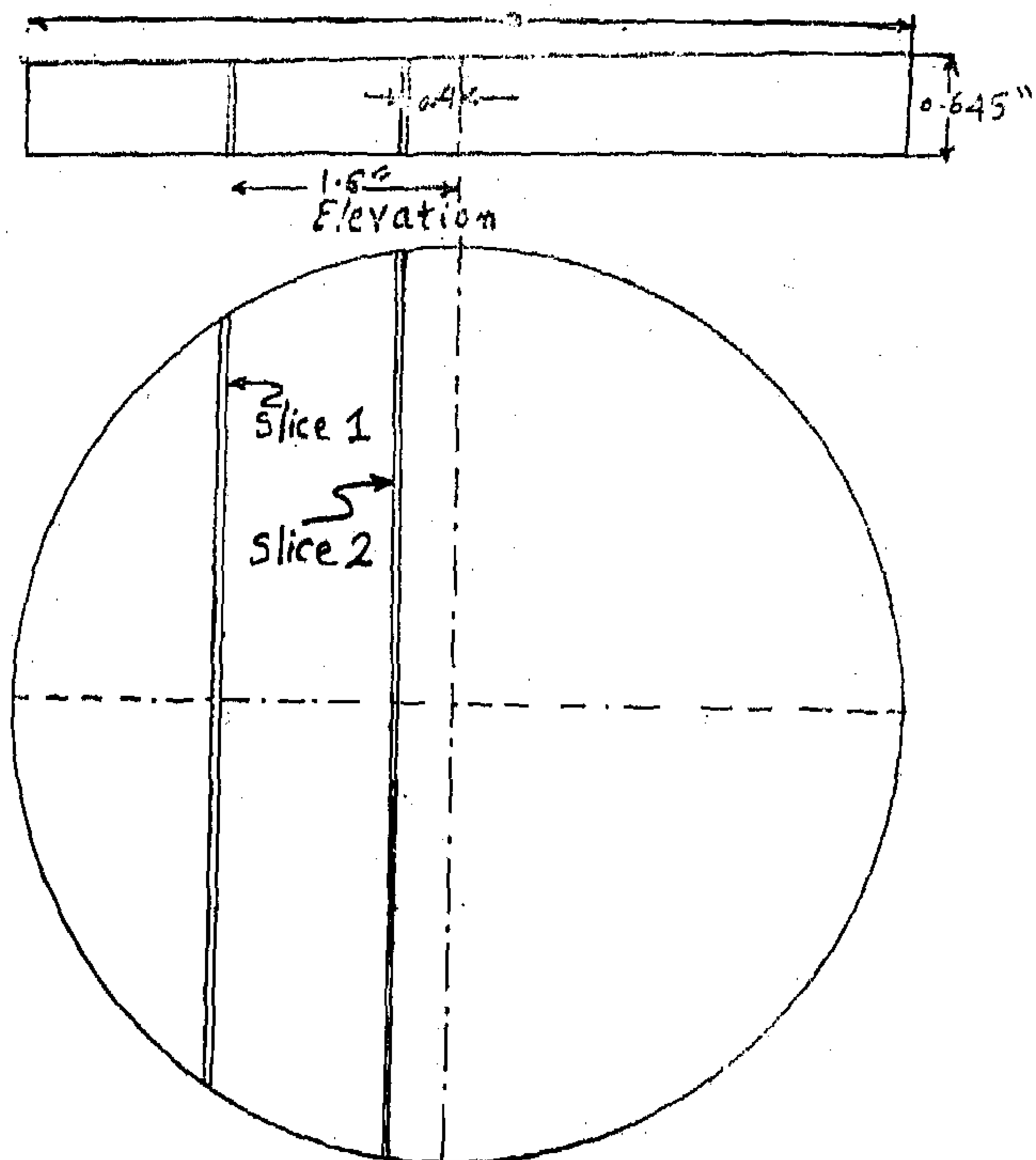


Fig. 1. Circular Model showing the positions of slices

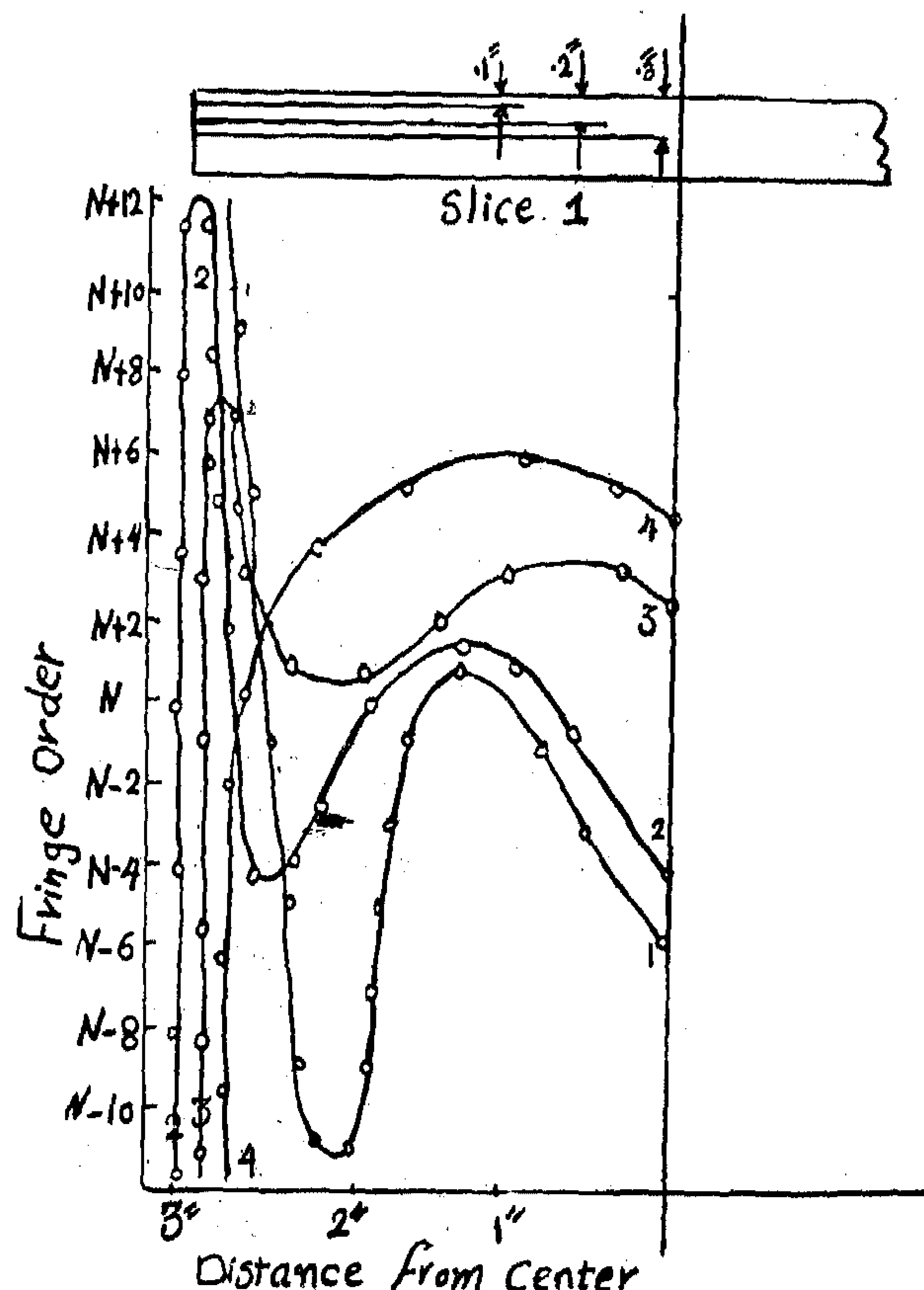


Fig. 2. Stress distritution in case of circular Model

STRESS DISTRIBUTION IN SHORT PILLARS

by

Dr. ALY H. GOMAH*

ABSTRACT

In underground mines, pillars in general, are either square or rectangular and can be categorized as short columns. It has been noticed in many cases, that these pillars spall off around the periphery under the overburden pressure.

Sometimes pillars may fail without spalling off, and failure in this case contains the pillar completely.

On the basis of photoelastic studies on two-dimensional models, it was concluded that the maximum stress occurs at the edges of the pillar.

Studies on high pressure cells have shown that the maximum stress occurs at or near the center.

In the present work, both square and circular epoxy models, simulating short pillars, were used to study the stress distribution in them by the application of the three-dimensional photoelastic technique.

The results obtained do not entirely agree with the previous informations. Stress distribution across the top of the pillar is found to be different from that at lower sections in the same pillar. At the pillar top, there are two distinct peaks of stress concentration; one occurs at the pillar edge, and another of less intensity takes place close to the pillar center. Below the top there is one peak.

INTRODUCTION

Knowledge of actual stress distribution in any structure is essential for its proper design. Designs based on average stress value may be faulty and lead to failure.

The stress distribution in mine pillars is a matter of conflict. There is no cut answer to the manner of how the stresses are distributed in mine pillars which are categorized as short columns. The purpose of this study is to determine the stress distribution in short pillars.

The technique followed in this investigation is that of studying the stress distribution on models simulating the short mine pillars using the "freezed-in" stress technique and the three-dimensional photoelasticity.

The models were stressed and the stresses were induced and locked in the epoxy models which were then sliced. The "locked-in" stresses were examined in a polariscope.

The results obtained were somewhat different. It is found that at the top of the pillar there are two peaks of stress concentration, one at the pillar edge and another close to the center. Below the pillar top, the peak at the edge disappears while that close to the center spreads out to cover a wider area.

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of the conductivity; of the original cvon-centration of sulfur dioxide content in the air. The second technique depends on the determination of the change in color of a standard material. By comparing with standard charts, it is possible to determine the sulfur dioxide concentration in the air. The most important instruments of the first technique are the AUTO-METER and TIRILOG. Neither instrument is suitable for a continuous indication of the level of sulfur dioxide in a polluting stream (9, 12). The most important instruments of the second technique are those developped by West and Goeke (20). Two instruments of this type are proposed by the Mine Safety Appliance Company in the U.S.A. The first is the GAS-DETECTOR and is suitable only to measure a certain polluting gas. The air is aspirated through a tube containing a solid material in the form of a cylinder about 10 centimeter long. The polluting gas produces a change in color, the density of which may be compared with standard charts. The concentration of the pollutant may also be determined by measuring the length of cylinder, of solid material, which has changed in color by using the suitable charts. The main disadvantage of the GAS-DETECTOR is that; for each polluting gas present in the polluted air, different equipment should be used. The second instrument is the UNIVERSAL-SAMPLING PUMP which is a manually operated piston pump and contains a rotating hed, which permits air sampling at different rates. This instrument has the main advantage that it can be used for all polluting gases by using for each gas the suitable detecting material.

NOTICE

The second part will be published in the further editions.

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clude the soil bearing pressure, the wind load on the stack, and the erection costs must be taken in consideration when the problem of pollution is to be solved only via increasing the stack height.

Other factors beside those mentioned above may affect the Air Pollution in one way or another and they include: exit-stack-velocity, stack diameter, exit temperature of gases, and the concentration of the pollutants in the polluting stream.

Theoretical Estimation of Sulfur-dioxide dioxide Pollution :

In the past four-decades or so, there have been developped a number of procedures for estimating the Effective Stack Height" which, in turn, is used to calculate the extent of pollution at ground-level. The stack gases are usually released to the atmospheric air with a certain exit velocity from the stack and at a temperature higher than ambient air temperature. Thus the Effective Stack Height is greater than the actual height of the stack because of both bouancy (thermal-rise) and momentum (velocity-rise) action. To estimate the value of the Effective Stack Height, one must calculate both the velocity and thermal rises.

The most important procedures include the Bosanquet formulae, the Sutton formulae, the Holland formula and the Briggs formula.

In 1936, Bosanquet (1) proposed a system of formulas to study the effect of relative motion of the plume and the surrounding atmosphere, as well as, the the effect of the atmospheric stability on Air Pollution.

In 1947, Sutton (18) put forward his formulas which help to determine the maximum ground-level concentration, the ground-level concentration, and the distance from stack to the region of maximum ground-level concentration. Many researchers found a disagreement between the Sutton formulas and actual measured values (13,14,15).

In 1947, Holland (11) proposed an emperical formula to calculate the plume rise. This formula was based on the observation of the plumes under average stability conditions. Therefore, the use of this formula is limited for these conditions only (17).

In 1951, Briggs (4) developped an emperical formula to calculate the plume rise above the top of the polluting stacks. The formula was based on observations in case of stable air conditions only. This, in turn, limits its use since it is largely based on the effect of the properties of the surface layer.

By comparing the Briggs formula with the Holland formula, it is found that the first gives the plume rise under stable air conditions, while the Holland formula gives the same under average stable conditions. Also, Briggs takes into consideration the gravitational force effect while Holland neglected this completely. Bosanqueet equations; in spite of being one of the oldest in this field; are still the ones mostly used uptil now.

EXPERIMENTAL MEASUREMENT OF SULFUR DIOXIDE POLLUTION :

On of the main problems of csombating Air Pollution is the availability and precision of the devices used to dectect and measure the pollutatnts. devices and techniques are used for determining the concentration of the pollutants. The choice of the suitable device depenas on many considerations such as, the degree of accuracy required, the costs... etc. Two tetchniques are available for measurements of the sulfur dioxide concentration in the atmosphere. The first depends on the absorption of the pollutant in a standard solution and the determination; by means

FACTORS AFFECTING AIR POLLUTION

Emission of pollutants from a certain polluting source is usually the same from day to day; the weather is the important variable which controls the Air Pollution episode. One cannot do much about the weather, but one can understand how it affects the Air Pollution problems (7,10). The chief physical variations of air are its density and humidity which are both affected by the prevailing temperature. Several other factors are less important but nevertheless play a role in the extent of the Air Pollution.

(a) Effect of Air Temperature on Air Pottution :

The rate of change of temperature with height is known as the "temperature-lapse-rate". The temperature lapse rate can be positive or negative depending on the prevailing conditions (8, 10, 16). Any hot plluting gases escaping from a certain stack during daytime will come into contact with a warm temperature layer. This leads to low temperature-lapse rate and hence the gses ascend to considerable heights until their temperature becomes less than the temperature of the surrounding air. Then these gases revert their motion downwards. Thus the concentration of the polluting gases is relatively small at ground-level. During the night, any hot polluting gases encounter a cold air layer which tends to a high lapse rate resulting in cooling the gases and making them revert their direction after reaching a relatively small height. This causes a high ground-level concentration of the pollutants, (7, 10, 16). The air is mostly unstable during day-time due to the upward currents and stable during the night due to the lack of such upward currents. Average-Air-Stability is encountered mainly during sun-set and sunrise. The upward currents play an important role in dispersing the polluting gases in the upper air layers. It should be stressed here taht from an Air Pollution point of view "Unstable-Air" is more favourable since the upward currents help to diminish the pollutant concentration at ground-level.

(b) Effect of Air Humidity on Air Pollution :

Humidity is one of the main physical variations of the air. The air temperature, which affects the Air Pollution as shown above, is affected by the existing humidity. Water vapor exerts a partial pressure and is less dense than the dry air at the same temperature and pressure, and thus the pollutants will move upwards to higher distances where more dilution of the pollutant occurs. (7, 10, 16).

(c) Effect of Wind on Air-Pollution :

Wind is one of the most important meteorological factors affecting Air Pollution. The term "wind" refers here to the air which has an approximately horizontal motion. Three facts about the wind must be observed, namely, the wind direction, the wind speed, and the wind turbulence. Wind direction specifies the ground area into which a pollutant will move, and the concentration downwind from a source varies inversely with the wind speed. The degree of turbulence of the wind determines the rate of diffusion of the pollutants (19).

(d) Effect of Stack Height on Air Pollution :

As the stack height increases, the pollutants will take a longer time to reach ground-level. This results in giving a chance for the pollutants to be diluted in the atmosphere before coming to the earth's surface. Many factors which in-

SOURCES OF POLLUTANTS IN PETROLEUM REFINERIES.

The Pollutants which are released to the air from Petroleum Refineries are mainly Aerisols, e.g. Smoke, Fumes, and Mists, and Combustion-gases. The gaseous pollutants are emitted to the air in large quantities. These gases are released to the air from two main sources; separation processes or conversion processes. They differ in composition and in their polluting effect The most common gases are sulfur dioxide, carbon monoxide, hydrogen sulfide, nitrogen oxides, and hydrocarbons and their simple oxidation products (5,6,9). The maximum allowable pollution limit is known as the maximum allowable pollution limit is known as the maximum allowable concentration (M.A.C.) and is given in table (1).

The plants and units which contribute mostly to the Air Pollution of Petroleum Refineries, and to an extent to the pollution of the Refinery surroundings, are given in Table(2). Sulfur dioxide is the main pollutant since other gases are relatively less important except may be Carbon monoxide. This latter is only present when unefficient burning occurs, which is not a common case; or at least should not be so; considering the production costs. Accordingly the present work will deal with the Sulfur dioxide pollution at the Mostorod Location.

Table (1) : M.A.C of the Different Refinery Gases

Polluting Gas	M.A.C. (ppm)	Polluting Gas	M.A.C. (ppm)
Sulfur dioxide	5	Carbon monoxide	100
Hydrogen sulfide	20	Nitrogen dioxide	5
Carbon dioxide	5000	Hydrocarbons	500

Table (2) Pollution Sources (5, 21)

Emission	
Oxides of Sulfur	Process fire heaters, boilers, hydrogen Sulfide flares, catalytic cracking units, regenerators, treating units, and decoking operations.
Hydrocarbons	Storage tanks, loading facilities, waste water separators, process fire heaters, boilers, pumps, valves, and distillation towers.
Oxides of Nitrogen	Boilers, process fire heaters, compressor engines, and catalyst regenerators.
Carbon Monoxide	Compressor engines, process fire heaters in case of incomplete combustion, decoking operations, and catalyst regenerators
Particulate Matter	Process fire heaters, boilers, decoking processes and catalyst regenerators.
Odors	Tank valves, pumps, waste water separators, and treating units.

AIR-POLLUTION AT THE MOSTOR OD REFINERY AND PIPELINE TERMINALS

PART ONE

By

Dr. NG. MOHEB-EL DIN HUSSEIN*

Dr. ENG. MOHAMED MEDHAT BADR*

ENG. MOHAMED SALEM ISMAIL AHMED**

The Petroleum Industry is the single greatest pollutant on earth Petroleum threatens the earth's ecology from the moment the crude oil leaves the well-head until it eteers he atmosphere as a gaseous effluent from cars and industrial stacks. Throughout the different phases of the Petroleum Industry, a type of pollution always occurs. The present work deals with the Air Pollution in an Egyptian Retnery and Pipelne Terminal at Mostorod (North-West of Cairo). The Mostorod site comprises a Refinery and three main Pipeline-Terminals. The Refinery was erected in 1969 and consists of several distillation plants together with their necessary heat transfer equipment. The Pipeline-Terminals existed at Mostostorod from the early 1950's. These terminals include the necessary pumping stations and heating furnaces. A quick glance at Mostorod shows that the layout is far from being ideal. Furthermore the location of the Refinery itself is not suitable considering the site location factors. It is quite clear that Cairo's only Refinery and main Pipeline-Terminal are neither adequately suitable nor properly planned. This tends to point out that an Air Pollution problem may be existing at Mostorod. The following research work deals with such a possibility. However, it should be pointed out that the Air Pollution problem study will be restricted to the Refinery-Pipeline Terminal Site only and not to the surrounding areas. It is hoped that a later Research work will complete the present work by studying the pollution problem outside the Refinery-Pipeline Terminals boundries. This research work will be published in two Parts. The first will deal with the necessary background needed for the study of any specific Air Pollution problem. The second will deal with the theoretical determination and experimental measurement of the Air Pollution at Mostorod. The second part will also include the discussions and recommendations to abate Air Pollution at Mostorod.

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RAWMATERIALS & CHEMICAL INDUSTRIES

INST. OF TINING, PETROLEUM &
METALLURGICAL ENGINEERS —
INST. OF CHEMICAL ENGINEERING

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مجلة جمعية المهندسين المصرية

المجلد الثالث عشر — العـدد الثالث (يولية ـ أغسطس ـ سبتمبر) ١٩٧٤

- تصدر المجلة ربع سنوية
- ترسل النصوص المطلوب موافقة هيئة التحرير على نشرها باسم السيد / رئيس التحرير . وهو غير مسئول عن فقد أو تلف أى نص .
- تنشر المجـلة المقـالات التى تسهم فى رفع مستوى العلوم الهندسية وطرق ممارستها .
- تقبل للنشر المقـالات باحدى اللغتين العربية أو الانجليزية ، على أن تقدم من ثلاث نسخ مكتوبة على الآلة الكاتبة ومعها ملخص بكل من اللغتين .
- تذكر أسماء أصحاب المقـالة كاملة باللغتين ومعها القابهم العلمية ووظائفهم .
- يراعى الا تتجاوز المقـالة ٨ صفحات بالمجـلة ، وفى سبيل ذلك يختصر الاشـتقاق الرياضى ويستعاض عن الجـداول بمنحنيات مرسومة بالحبر الشينى الأسـود ، علـى أن يشـغل المنحنى نصـف صفحـة على الأكثر ولا يشغل صفحة كاملة الا فى حالات اسـتثنائية وسيصـغر أى منحن الى تلك المقاسات .

  ويراعى الا يقل ارتفاع الحـروف أو الأرقـام على المنحنيات المنشورة عن ٣ مم بعد التصغير .
- يعنى بذكر المراجع المستقى منهـا المقـال وتصنف تبعا لاسم المؤلف ثم العنوان ثم المجـلة أو الكتاب وتاريخه .
- تقـدم لصاحب المقـال تجربتان للطبـاعة وترفق بالأولى نسخة من مصطلحات التصحيح التى يؤدى اتباعهـا الى رفع كفـاية التصحيح وتقليل الوقت الضائع فيه .

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جمعية المهندسين المدنيين
جمعية المهندسين المعماريين
جمعية مهندسي الري

input from considerations of planning and of the environment, of the loading, of the construction system best suited. Whatever the material, the structural design must be thorough and safe, and must utilize the latest knowledge of structural behavior. Consideration will be given to the codes and standards, to limit states, to the effect of fatigue, fracture, and earthquake, and to the influence temperature extremes. The strength of members, of connections, and of the complete structure must be assured.

The Regional Conference in Bangkok treated more recent developments on structural subjects. The program is enclosed.

(d) **The Conference Organization**

The organization of the Conference will be a joint effort between the Egyptian Society of Civil Tngineers and Lehigh University in the U.S.A. — both will work closely to develop the program and to select specialists from all over the world to participate.

The conference will be of immediate use to both Egypt and the United States. Egypt will be able to use the specialists to help in solving its housng problems and to discuss the current efforts made to house the returning population of the Suez Canal cities : Suez, Ismailia, and Port Said.

The totaly demolished city of Kantara will offer a unique opportunity for the application of newly gained knowledge in the planning and design of low cost housing systems.

The United States will learn from the solutions used in other countries and will be able to compare these solutions with its own needs.

To enhance usefulness and timely availability of material, it is anticipated that the conference proceedings will consist of two-page summaries of each presentation. More extensive details would be references as prepared for the comprehensive MONOGRAPH on tall building.

THE JOINT COMMITTEE ON TALL BUILDINGS

Under the auspices of the Joint Committee on Tall Buildings, a major international activity, there is under preparation a MONOGRAPH covering many of the topics of this proposed conference. The effort on the MONOGRAPH has now reached the stage where new material is becoming available in a systematic fashion. It would be both appropriate and desirable of this to be presented during the conference week — it is expected that its impact would be direct and major.

The Joint Committee is a multi-disciplinary international activity sponsored by engineering, architectural, and planning professionals. It is concerned with stimulating the utilization of the most recent findings from research laboratories and from design practice, and it sponsors local, regional, and international conferences, and publishes proceedings from these conferences, as well as other reports.

The professional society sponsors of the Joint Committee are: the International Association for Bridge and Structural Engineering, the American Society of Civil Engineers, the American Institute of Architects, the American Institute of Planners, the International Federation for Housing and Planning, and the International Union of Architects. The enclosed brouchure describes further particulars of the Joint Committee.

The Joint Committee is a "Category C" member of UNESCO.

A Regional Conference on Tall Buildings was held in Cairo, Egypt under the organization of the Egyptian Society of Civil Engineers and the sponsorship of the Joint Committee, in January 1974. The enclosed program shows that both the interest and expertise of the professionals provides a most appropriate foundation for the proposed conference.

PRINCIPAL INVESTIGATORS :

EGYPT : Dr. Ahmed Moharram Ahmad
Eng. Hamed El-Kaddah
Dr. Ing. Gamal Nassar

USA : Dr. Lynn S. Beedle

Further Information

For any further information any of the principal investigators may be approached.

Conference Secretary
G. NASSAR

4. they will be avilable to give special lectures in Cairo outside the framework of the Conference... e.g. universities or engineering societies.

5. they will participate in the anticipated Seminar to be arranged together with the Ministry of Reconstruction of Egypt on the subject of "The Redevelopment of the Suez Canal Zone". This offers a singular opportunity for Egypt to make use of such a large number of top experts and to establish a standard for similar future development. The focus of this Seminar will be the the residential and community programs for the returning population, for the technical manpower, for construction and for industrial and port development.

In addition, invitations to attend the conference will be sent to selected UNESCO specialists.

(c) **The Conference Phases**

Part A : **PLANNING AND ENVIRONMENTAL CRITERIA**
5, 6, and 7 January 1957, Cairo, Egypt

A plenary session and a workshop will consider all aspects of the planning and environmental criteria concerned with housing in developing countries, in particular, the role of tall buildings.

The conference will commence with a consideration of the need for LOW COST HOUSING and for high-rise buildings, from the viewpoint of sociological, economic, and political measures. This will include all the factors affecting the very existence of cities — such as the effects of the tall buildings on the total urban environment, on local, community, and regional life, on social and human factors, and on the need for communication, contact, choice, opportunity, and mobility.

The problems of transportation, energy conservation, operation and maintenance, and of project management, all are essential aspects.

As a result of the international conference on tall buildings held at Lehigh University in August 1972 (program enclosed), and especially the various national and regional conferences held in many countries around the world (see Schedule 8B-1, attached), some information has already been accumulated. The enclosed table of contents of the "Preliminary Publication" for the National Conference in India is illustrative of the coverage of some of the "Part T" topics. It will be the objective to assimilate this information in such a way that it may find practical utilization, with special thrust on the present program for the redevelopment of the Suez Canal Cities.

Part B : **LOADING CRITERIA AND BUILDING CONSTRUCTION SYSTEMS**
6, 7, and 8 January 1975, Cairo, Egypt.

A plenary session and a workshop will consider all aspects of the loading criteria and the building construction systems concerned with housing in developing countries, in particular, the role of tall buildings.

The demand for housing indicates a need for examination of all aspects concerned with construction systems. Certain construction systems and methods of management appear appropriate in some situations and in some countries, while other countries have found success in other directions. The conference will consider inter-related topics such as waste disposal, cleaning, fire protection, maintenance, and the use of solar heating. Basic to anv design and construction is a knowledge of the foundation conditions and the loading criteria. Earthquakes, wind, fire, and their interaction with the environment need to be considered.

The conference in Hong Kong provided both an opportunity to examine the tall buildings used for housing and to discuss critical problems. A portion of the Hong Kong program is enclosed.

Part C : **DESING OF THE STRUCTURE**
7, 8, and 9 January 1975, Cairo, Egypt

A plenary session and a workshop will consider all aspects of the structural design of steel, concrete, and masonry buildings as needed for housing in developing countries.

The design of the structure requires

REGIONAL CONFERENCE
ON
LOW COST HOUSING IN DEVELOPING COUNTRIES

CAIRO 5 — 11 JAN., 1975

The Three-Part Conference will consider the following distinct aspects of the problems of the Low Cost Housing :

(A) PLANNING AND ENVRONMENTAL CRITERIA

(B) LOADING CRITERIA AND BUILDING CONSTRUCTOIN SYSTEMS

(C) DESIGN OF THE STRUCTURE

SUBJECT : Under the excess Forign Currency Program of the **United States of America**, it is proposed to hold a three-part Conference within the period 5 to 11 January 1975, in Cairo, Egypt, on the above theme.

THE CONFERENCE WEEK

(a) Purpose of the Conference

The exploding population in developing countries has created an urgent need for housing, housing which must be economic yet human, safe yet compact, livable yet socially acceptable. Increasing consideration is being given to the role of tall buildings in filling these needs. Yet, the tall building introduces its own effects, and these must be considered with the end objective in view.

The emphasis is given to "housing" for a number of reasons. First it is such an urgent need in so much of the world. Second, both economic and energy conservation reasons require a consideration of hi-rise housing. Third, the rapid increase in population coupled with disappearing agricultural land (precious arable land is being rapidly absorbed by low-density, suburbs) strongly points to more "vertical living" in the future.

The phases involved in the development of such housing may be broken down into three distinct yet related parts — it is these three parts which form the topics of the conference, as outlined below. Each part of the conference will be an entity unto itself, but, because of the inter-related nature of the whole problem, it is highly advantageous to have the opportunity for interaction between the participants. The proposed scheduling of the separate parts of the conference will achieve this aim,

Each part will last about three days, and will include one plenary session where prepared papers will be presented, summarizing the needs and the possible solutions, and a workshop lasting two days where each separate topic will be discussed by relatively small groups of specialists.

The three parts will overlap to a slight extent, and will take place within the week of 6 to 11 January 1975 in Cairo, Egypt. It is planned to have essentially continuous workshops with the plenary sessions on 6, 8, and 11 January, respectively. This will allow both the desired interaction between the various specialists, as well as the possibility of attendance at the plenary sessions and workshops.

(b) Associated Opportunities

It is expected that the Conference Week will attract as many as 150 specialists from all parts of the world — about 30 of these specialists will attend with separate financial support. Such a concentration of expertise will be unprecedented, and will be fully utilized in the following ways :

1. the experts will present lectures at the plenary sessions.
2. they will participate in the workshops relevant to their erpertise, and lead the discussions.
3. they will be available to give advice to practical problems which exist either within Egypt or elsewhere in the world.

its construction supervised by Freeman Fox & Partners, consulting engineers, of London, who were appointed late in 1968. It was built by the Anglo-German Bosporus Bridge & Engineering Co Ltd. of Darlington and Hochtief AG of Essen, who won the contract by competitive tender.

The principal dimensions of the bridge are:

Main span	1074 m
Side spans east	255 m
west	231 m
Total length	1560 m
Clearance over high water	64 m
Carriageways	Dual three-lane footpaths
Toll lanes	16 (four reversible)
Overall deck width	33.4 m
Tower height (above foundation blocks)	165 m

Main cables Two, each of 10450 wires (19 strands of 550 wires) plus 4 strands of 190 wires in each backstay; all wires of 5 mm dia and 160 gk/mm2 uts.

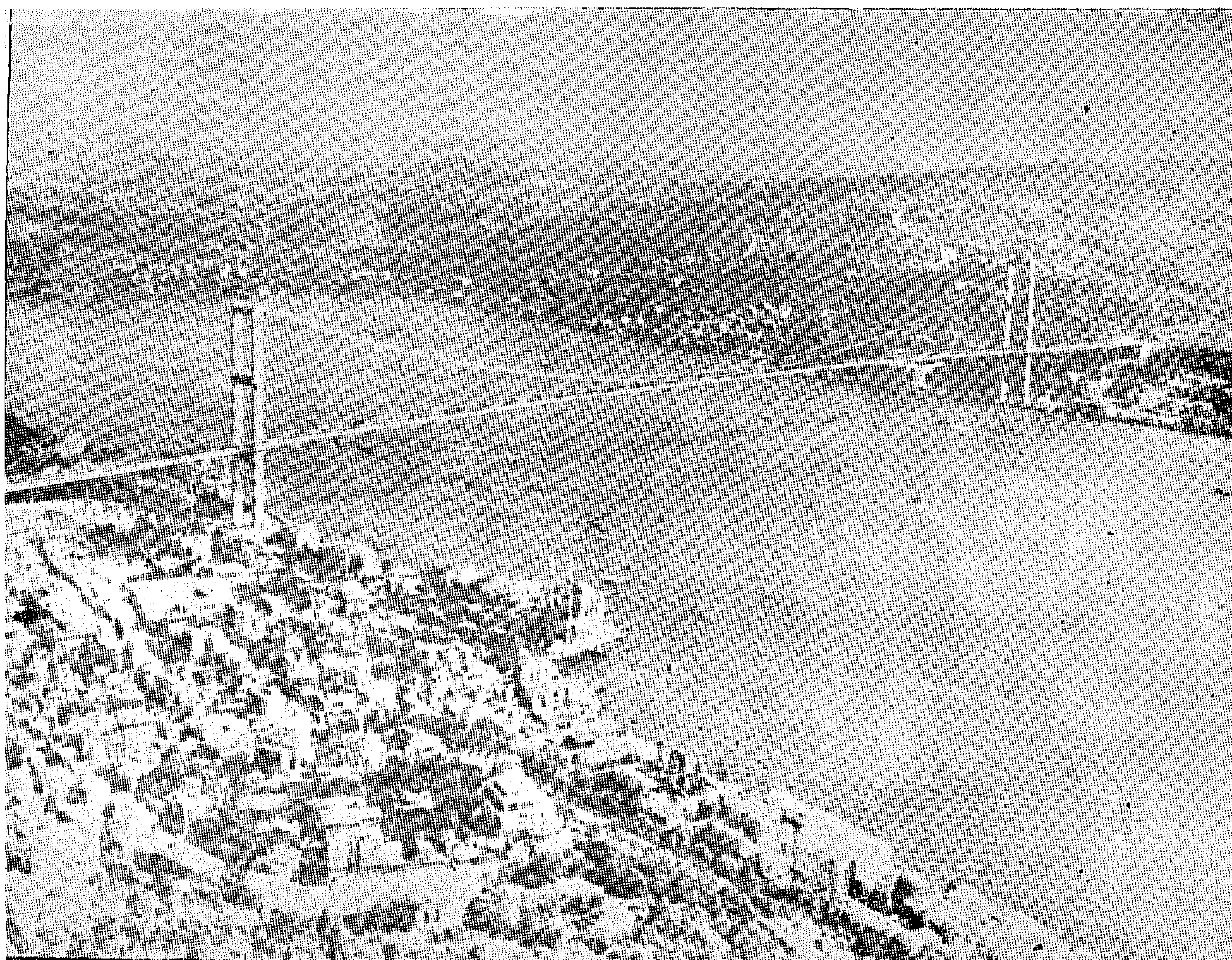
Load in backstay	15,400 tonne
Anchorage deadweight east	50,000 tonne
west	60,000 tonne

1) Client: Karayollari Genel Mürdürlügü (General Directorate of Highways) Republic of Turkey

2) Consulting Engineers: Freeman Fox & Partners, London SK1, and Petek, Istanbul

3) Main Con tractor: Anglo-German Bosporus Bridge Consortium

Dr. S. MORTADA



with a conventional open truss stiyening girder. Tests on models of the deck section showed that it would remain stable at all anticipated speeds and directions of wind.

Supporting the side spans from below, instead of suspending them from the main cables, made their erection independent of the central span and removed them from the critical path programme for the superstructure, thus making possible a further reduction in the construction period as a whole. The arrangement offered little saving in cost but the fact that the spans are not suspended means that live load on the side spans is not transferred to the tower tops which therefore deflect less, leading to reduced bending stresses, and some saving of steel, in the towers.

Although prospective contractors were invited to tender for supplying and placing pre-formed parallel wire strands for the main cables, the successful contractor preferred to 'spin' them as has been done for all the major suspension bridges. No tender based on pre-formed strands showed any advantage.

Istanbul is in an earthquake zone and it is estimated that a quake of intensity 8 on the Mercalli scale may occur been designed to resist the equivalent shock acceleration in the bedrock of 0.1 g in any direction.

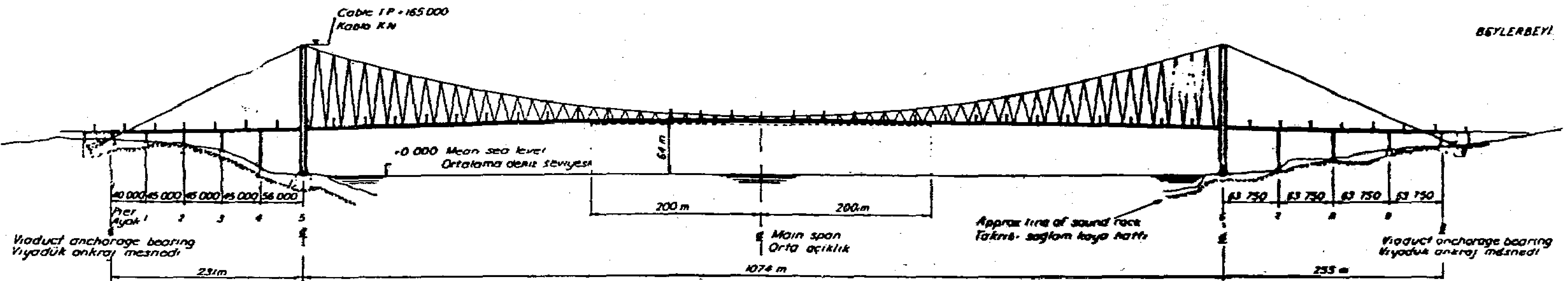
Although the sub-structure of the bridge had to be founded generall deeper than had been expected because the rock proved to be more broken than boreholes had indicated, no major construction problems were encountered. Despite both main piers being sited close to the water edge, and excavations being taken to a depth of 25 m below sea level, very little water nenetrated and small pumps were sufficient to keep the workings dry.

The steelwork for each of the two towers was prefabricated by a di;erent sub-contractor in Italy, with erection at site by the main contractor who also undertook the spinning of the main cables. Fabrication of the steelwork for the deck and the side spans was shared between one of the sub-contractors in Italy and the main contractor at a work in the UK. Assembly of the prepared steelwork for erection into the main and side spans was completed by the main contractor in a yard a few miles from the bridge and taken by barge to the site.

The main span was erected from the centre towards the towers. Box sections, of full deck width and 18 m long were raised by beams and tackle running along the main cables. They were temporarily bolted together and the welded joints were not made until the steelwork was substantially in place so that most of the dead load deflection had been absorbed. The deck of each side span consists of a reinforced concrete slab acting compositely with steel cross beams and two main longitudinal box girders that were lifted into position by gantries running up and down the backstays.

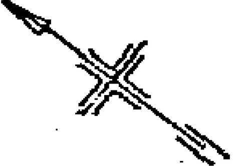
The bridge has been built as an integral part of Turkey's Second Five-vear Plan of Reconstruction. The non-Turkish part of the cost, approximately £10 million (US $24 million), was arranged by the European Investment Bank, with Government-guaranteed loans at low interest rates from the United Kingdom, Germany, Italy and France. The balance was provided by the Turkish Government. Under the terms of the international loan sub-contractors from Italy, France, Germany and the UK, as well as Turkey, participated in the project. All the capital cost and interest will be repaid out of the toll revenue.

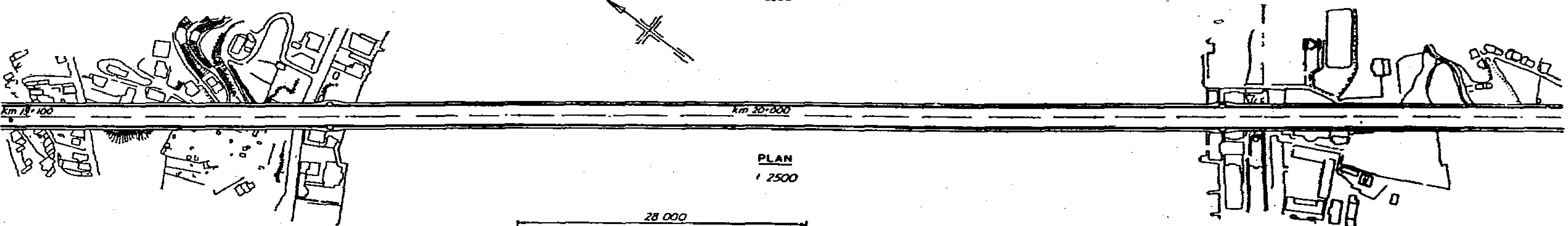
The bridge is owned by the Karayollari Genel Müdürlügü which operates it as a toll bridge. Together with the toll system and other services, the bridge was designed and



ELEVATION

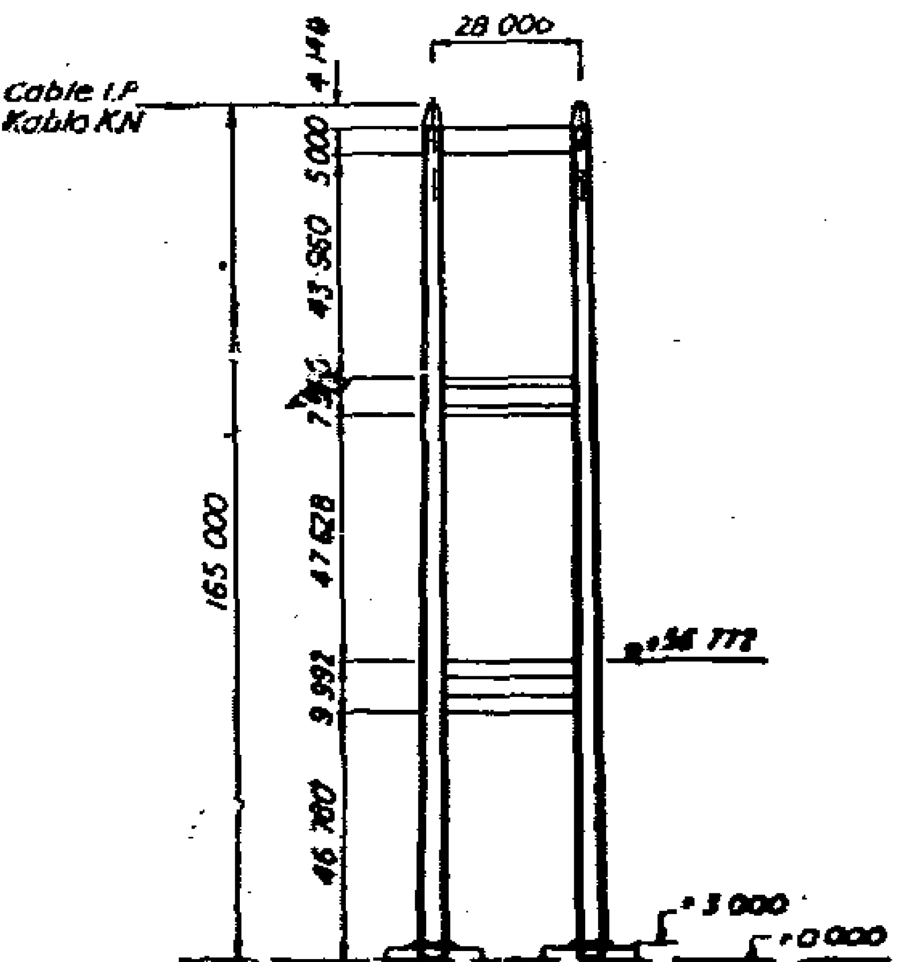
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PLAN

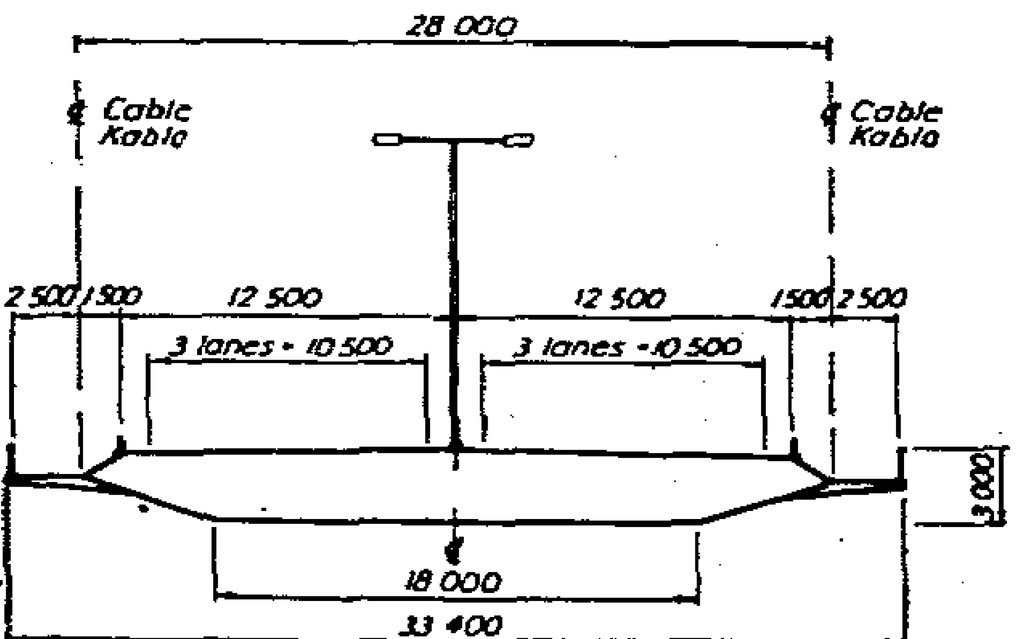
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ELEVATION OF TOWERS

KULELERİN GÖRÜNÜŞÜ

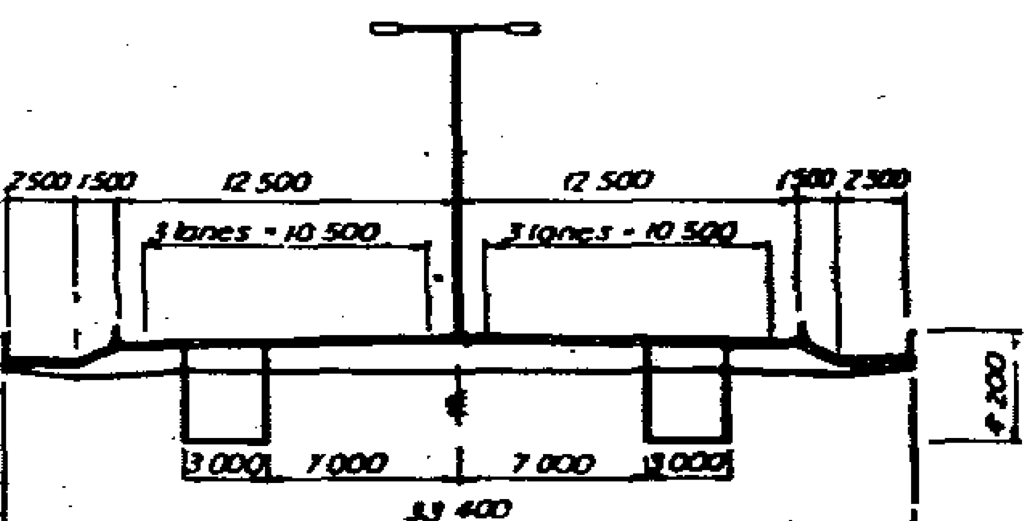
1:1000



SECTION THRO' SUSPENDED DECK

ASMA TABLIYE KESİTİ

1:200



SECTION THRO' APPROACH SPANS

YAKLAŞIM AÇIKLIKLARINDA KESİT

1:200

T.C.
BAYINDIRLIK BAKANLIĞI
KARAYOLLARI GENEL MÜDÜRLÜĞÜ

İSTANBUL BOĞAZİÇİ KÖPRÜSÜ	BOSPORUS BRIDGE ISTANBUL

GENEL TERTİP

GENERAL ARRANGEMENT

CONSULTING ENGINEERS FREEMAN FOX & PARTNERS LONDON SW1	SCALE AS SHOWN DATE OCTOBER 1968	131/C/G-1

BOSPORUS BRIDGE, ISTANBUL (TURKEY)

(IABSE — BULLELIN 30)

The Bosporus Bridge was opened to traffic on 30 October 1973. It is a suspension bridge with fourth longest span (1074 m) in the world and was built in the commendably short period of 3¼ years. In the first three months of its operating life an average of 22,000 vehicles used it daily and the toll revenue seems likely to recover capital cost (£15 million; US S36 million) within three years.

The bridge is the first road crossing to be built between Europ and Asia south of the Black Sea. It joins together the European and Asian parts of Turkey that are separated by the Dardanelles, the Sea of Marmara and the Bosporus. Istanbul, the country's largest city, is also divided by the Bosporus and the bridge, which is part of the Peripheral Highway due to be completed around the City during 1974, forms a connection hitherto provided by ferries. Before the bridge was opened, delays to big vehicles sometimes lasted up to 48 hours or more.

With dual three-lane carriageways the bridge forms the vital link between the road networks of Europe and Asia. The footpaths across the bridge will also enable pedestrians to walk across the Bosporus and enjoy the spectacular views ar they do so. Built 64 m (210 ft) above the water, one of the world's busiest sea-lanes, and crossing it in a single leap, the bridge still allows the largest ships afloat to make their way between the Black Sea ports and the Mediterranean.

The Bosporus Bridge is similar in general form and design to the Severn Bridge in the UK (designed by the same consulting engineers) and, apart from a main span that is 76 m longer and a deck that carries six lanes as compared to four, it is distinguishable from the Severn only by one notable feature: that the side spans of the Bosporus are not hung from the main cable but are supported by slender columns from the steep rocky slopes below.

To fit the topography of the steep banks on both shores, and to carry the roadway sufficiently high above the water, the overall length of the bridge, anchorage to anchorage, had to be about 1500 m. With conventional proportions of side span to main span, the side spans would have been 300 m and the main span 900 m with the piers for the towers founded in the water. Because of the steep sides, the piers would have been in comparatively deep water, about 30 m, and located in the main shipping lanes. The of a ship hitting the piers during construction, or afterwards, were considerable and, despite the implications arising from a longer main span, it was decided to locate the towers on dry land. This both simplified construction of the piers and shortened the estimated time to build them by as much as 18 months, with a substantial reduction in cost.

Previous experience, plus studies made for other similar bridges, convinced the designes that, over the Bosporus, they should adopt the all-welded box stiffening girders with an asphalted battle-deck top glange, together with the triangulated suspender system, as had been introduced so successfully at Severn. Cost studies indicated that these arrangements would produce a further saving of about 20% as compared

Example 2 :

The same above section, but subjected to M_u = 75 m.t.

Solution :

C_I = 1.96, the results are as follows :

	Elastic	B.S.72	B.S.69	ACI-71	ACI-63	Russian
α	0.57	0.30	0.18	0	0	0
j	0.825	0.678	0.775	0.70	0.70	0.675
$A_s(cm^2)$	38	48.5	40.5	45	45	46.5
$A'_s(cm^2)$	22	14.1	7.3	--	--	---
Total	60	62.6	47.8	45	45	46.5

6) CONCULUSIONS

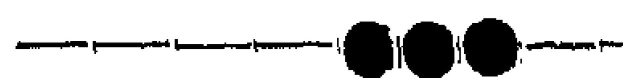
1) In general, it is clear that the design of singly reinforced sections subjected to simple bending according to the most codes, and also the elastic design, is nearly the same.

2) On the other hand, there exists a wide difference between the codes in defining the limit of singly reinforced sections, as well as in designing doubly reinforced sections.

3) It is also observed that thers is a general trend in the newest provisions of the codes to increase the compression reinforcement.

7) REFERENCES

1. British Standard code for use of reinforced concrete in buildings, B.S. 72 and C.P. 114—69.
2. American Concrete Institute Building Code Requirementes for Reinforced Concrete, ACI-318 — 71 and ACI 318-63.
3. Marashov, Sigalov, Baikov : Design of reinforced concrete structures Mir publishers, Moscow 1968.
4. TI Haung : Minium steel design of doubly reinforced sections, ACI-Journal, August 1972.



of d'/d = 0.1, f = 2800 kg/cm2 and F'_c = 200 kg/cm2. From figure 2 and the following examples, we come to the following conclusions :

i) Elastic Design :

It gives much greater compression steel ratio than all other ultimate strength design codes, and at the same time smaller tension steel area. The increase in the compression steel compared with the B.S. code is more than 25% and with the ACI code is more than 80%. The tension steel required by the elastic design for doubly reinforced sections is smaller than that required by all compared ultimate strength design codes, which could results into undesirable eccessive cracks at ultimate stage. On the other hand the total steel area of the section is greater than all the ultimate strendth design methods.

ii) The B.S. — Codes

The B.S. 72 is one of the most conservative ultimate strength design codes. It gives compression steel greater by about 30% than that of the B.S. 69, which shows the new trend of increasing the compression steel. Also the tension steel is greater than all other ultimate strength design codes.

The B.S. 69 — code (CP114) gives smaller tension, compression, and total steel area than the B.S. 72 code, its values are more close to the other compared codes.

iii) The ACI — 318 codes :

The new provisions of the ACI 318-71 code specifies greater compression steel (about 30%), ant slightly smaller tension steel area than the previous code of 1963 (Ref. 4). Both values are greater than that of the 1956 code. Again the new trend can be observed. The ACI codes give smaller compression reinforcement than the B.S. codes.

iv) The Russian Code :

It gives the smallest compression reinforcement of all the compared codes. The total steel area is nearly the same for most of the codes.

5) EXAMPLES

Example 1 : A reinforced concrete section with effective depth d = 85 cm, breatth b = 20 cm, f_y = 2800 kg/cm2, F'_{cu}= 200 kg/cm2 is subjected to ultimate moment M_u = 100 m.t. (d'/d = 0.1). It is required to find the steel area A_s and A'_s

Solution :

$$d = 85 = c_1 \sqrt{\frac{100 \times 10^5}{200 \times 20}} \quad ; \quad \text{therefore} \quad c_1 = 1.70$$

From figure 2 we get — and j-values corresponding to C_I = 1.70 according to the different codes. The results can be summarised as follows :

	Elastic	B.S. 72	B.S. 69	ACI-71	ACI-63	Russian
α	0.8	0.505	0.39	0.29	0.22	0.20
j	0.86	0.70	0.817	0.743	0.72	0.693
$A_s (cm^2)$	48.5	60	51	56	58	60.5
$A'_s (cm^2)$	39	30	20	16.2	12.2	11
Total	87.5	90	71	72.2	70.2	71.5

β = 0.55 (Ref. 3), which gives for the compared example :

q_{max} = 0.4 and p_{max} = 2.85%

From the above comparison the limit of singly reinforced sections for the case of f_y = 2800 Kg/cm2 and f'_c = 200 kg/cm2 (f_c = 250 kg/cm2) according to the different codes can be summarised as follows :

	Elastic	B.S.69	B.S.72	ACI 71&63	Ruissian
β	0.472	0.50	0.50	0.52	0.55
q_{max}	0.197	0.277	0.2875	0.375	0.40
p_{max} %	1.407	1.960	2.050	2.680	2.85

II) Doubly Reinforced Sections :

Figure 2 shows the comparison between the different codes by design of doubly reinforced sections. This figure gives a simple design procedure, as well as minimum total steel area according to the compared codes. It should be noted that the curves are prepared for the case

Code Comparisson for:

U.S.D. of Rectangular Sections with Compression Steel.

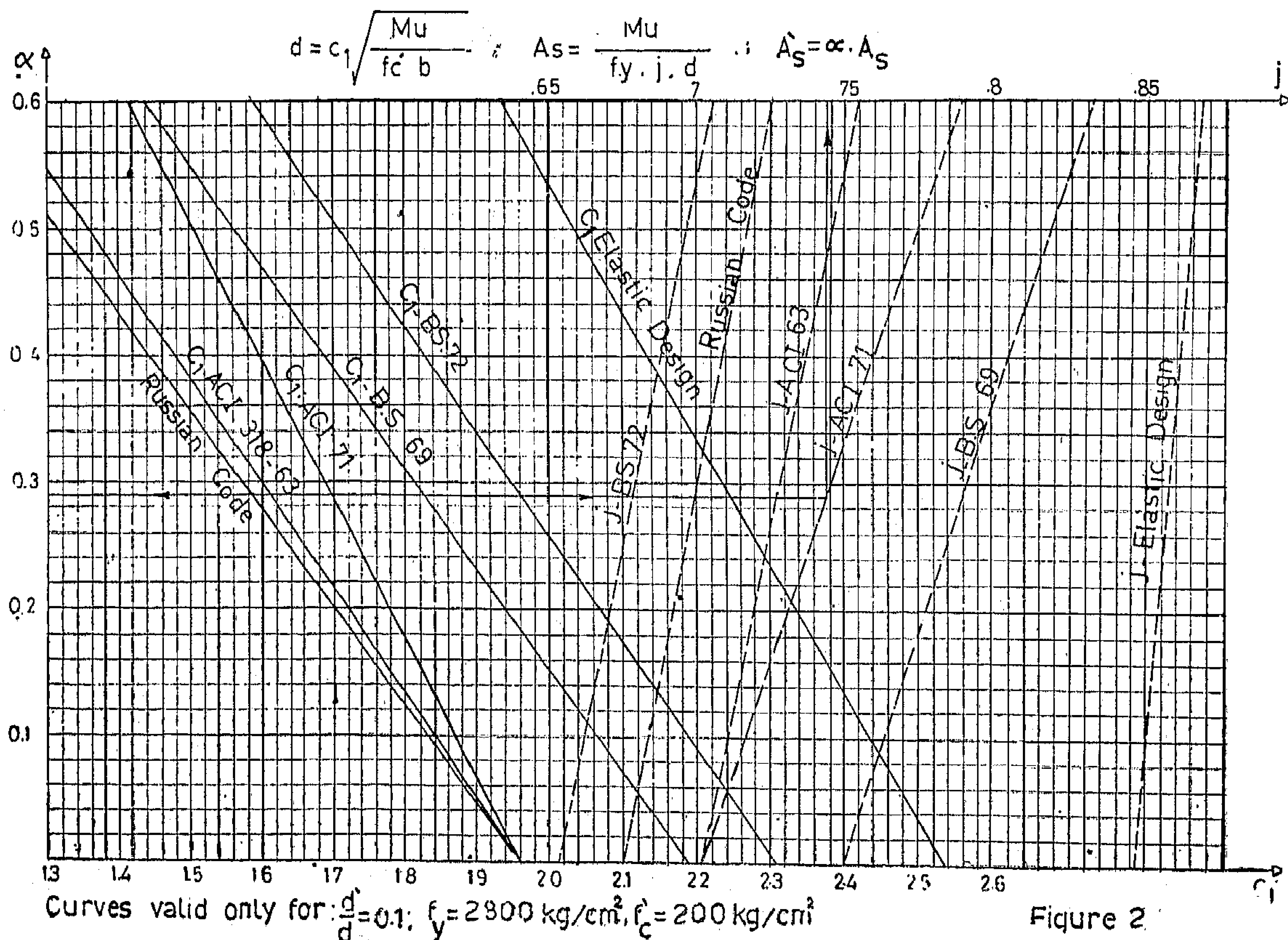
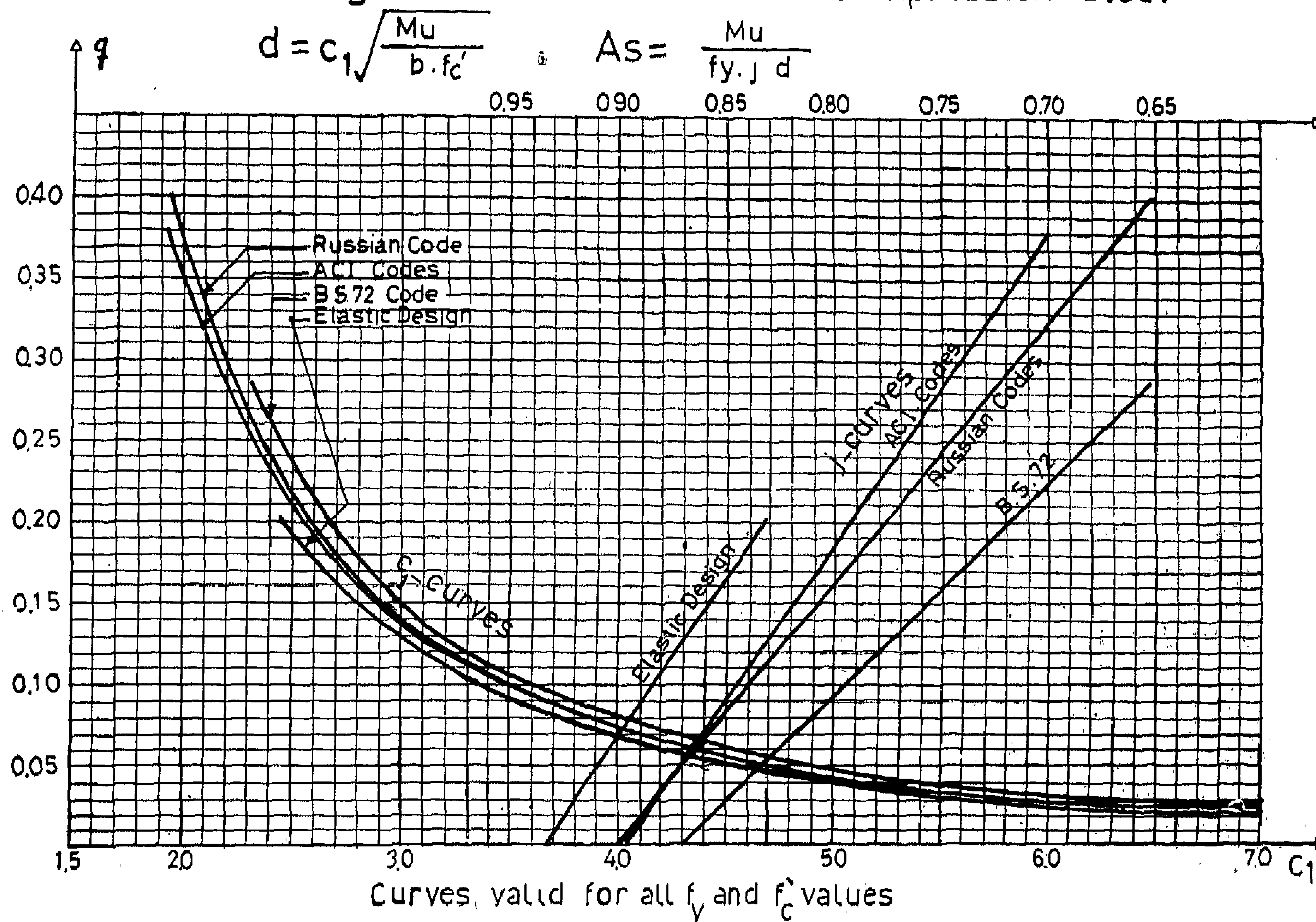


Figure 2

Codes Comparisson for:

U.S.D of Rectangular Sections without Compression Steel



Curves valid for all f_y and f'_c values

Figure 1

sections is reached when the depth of the compression zone is equal to half the effective depth of the section.

According to the B.S. 72 : q max = 0.2875 and p max = 2.05 %

Accorting to the C.P. 114 : q max = 0.275 and p max = 1.98 %

It should be noted that the q max value specified by the B.S. codes does not depend on the steel and concrete quality, It is felt that this is not very accurate.

iii) American Concrete Institute Codes (ACI-318) :

Both A CI-318-71 and 63 (Ref. 2) specify that the maximum tension steel ratio of singly reinforced sections should not be greater than 0.75 the ratio corresponding to the balanced condition The balanced condition according to the ACI codes is assumed to be reached when the strain of the concrete in compression fibers is equal to 0.003. This gives :

$$q_{max} = \frac{0.002\,\eta\,E_s}{f_y + 0.003\,E_s}$$

f 0.003 E

where η is a factor depending on the concrete strength f'_c, and thus the q max value depends on f_y and f'_c. For the compared example we get :

$q_{max} = 0.375$, and $p_{max} = 2.68\%$ and $\beta = 0.52$

v) The Russian code :

It specifies that the limit of singly reinforced sections is reached when

3) BASIC ASSUMPTIONS FOR THE COMPARISON

Ultimate strength design according to the different codes is based on assumptions which are not identically the same. Thus there exists a wide difference among the design equations of the codes. To unify the comparison a critiria to obtain the minium steel area was applied to all the codes, regarding the design of doubly reinforced sections. This critiria gives maximum tension and minimum compression steel area. The total steel amount should also be minimum.

An attempt was carried out to unify the expressions of all code design equations, and they are presented in the following form :

$$d = c_1 \sqrt{\frac{M_u}{f'_c . b}} \quad , \quad A_s = \frac{M_u}{f_y . j . d} \quad , \quad A'_s = \alpha A_s$$

This form gives a simple design procedure of doubly reinforced sections. as well as it is familiar to engineers designing by the elastic method.

In the obove equations f'_c is the cylinder strength of the concrete after 28 days. In code eqcations where the cube strength f'_c is adopted the relation $f'_c = 1.25\ f'_{uc}$ has been used.

It should be noted that the following comparison is carried out for the ultimate moment ignoring the load factors, which are also different among the codes. To include the elastic design method in the comparison, a factor of safety of 2.0 is applied.

4) Comparison

I) Singly reinforced sections :

Figure 1 shows a comparison between different codes (including the elastic design) for design of singly reinforced sections. From figure 1 it can be seen that for under reinforced sections all design methods give nearly the same results (depth and steel area). The definition of the limit of singly reinforced sections is widely different. Some codes specify a maximum tension steel ratio as a limit for singly reinforced sections and some other codes specify a maximum ratio of the compression zone to the effective depth of the section. The limit depends on the concrete srength and yield stress of the steel. As example for f_y = 2800 kg/cm2, and f'_c = 200 kg/cm2 (fcu = 250 kg/cm2), the limit of singly reinforced sections after which compression steel should be used, according to the different codes is as follows :

i) Elastic Oesign :

The limit is reached at the balanced condition, i.e when the stresses of concrete in the compression reachs f'_c max = f_{cu} /3, and the stresses in the steel reachs the value $f_s = f_y$ /2. This condition gives :

$$\beta = z/d = \frac{n . f_c}{f_s + n . f_c} = \frac{2n . f_{cu}}{3f_y + 2n . f'_{cu}} = \frac{10\ f_{cu}}{f_y + 10 f'_{cu}} \doteq 0.472$$

(assuming that n= 15, f'_{cu} = 250, f = 2800) The max tension steel index q is : q_{max} = 0.197

The max tension steel ratio p_{max} = 1.407%

ii) British Standard Codes : (B.S. 72 and C.P. 69)

Both B.S. 72 and C.P. 114 - 69 (Fef. 1) specify that the limit of singly reinforced

PRECAUTIONS BY ULTIMATE STRENGTH DESIGN IN FIEXURE

By

Dr. ING. SHAKER EL-BEHAIRY*

1) INTRODUCTION

In the last few years the application of the ultimate strength design method has been widely atopted by most of the reinforced concrete design codes. The saving in the compression steel in doubly reinforced sections is one of the main advantages of this new design method. The reduction in the compression steel area reachs in many cases 100%.

However, it has been observed that most of the codes in their newest provions have become more conservative, and that there is a general tendency to increase the ratio of the compression steel. This new trend is based on many experimental work on doubly reinforced sections, which have shown that compression steel is not only needed to produce the required strength but also it is effective in :

i) minimizing effects of creep of concrete.

ii) decreasing the long-time deflection specially for doubly reinforced sections which have a limitted depth.

The following comparison between different codes is carried out to show clearly this new trend of increasing the compression steel. The comparison shows also that, most of the codes give nearly the same results for design of singly reinforced sections, (figcre 1). On the other hand there exists a great difference among the codes regarding the design of doubly reinforced sections (figure 2).

2) NOTATIONS

The following notations are used when no others are specified at a certain positions.

A_s = Area of tension steel.

A'_s = Area of compression steel.

d = depth from concrete compression outer fibers to the centreline of the tension steel.

d' = depth from concrete outer compression fibers to the centreline of the compression steel.

Z = depth from concrete outer compression fibers to the neuteral axis of the section.

β_1 = ratio of z/d.

F'_c = ultimate cylinder compressive strength of the concrete.

F'_{cu} = ultimate cube compressive strength of the concrete.

F_y = yield or proof stress of the steel.

E_s = modulus of elasticity of the steel.

P = percentage of the tension steel.
= A_s / bd.

Q = tension steel index
= $p.f_y \,/\, f'_c$

= ratio of the area of the compression to the tension steel
= A'_s/A .

M_1 = ultimate moment of the section.

* Structural Engineering departement, Faculty of Engineering, Ain Shams University.

TABLE 3.- COMPARISON OF DISCHARGES COMPUTED BY DIFFERENT METHODS

No.	$\frac{y_e}{D}$	Q in cfs (Van Leer)	Q in cfs (Rohwer)	Q in cfs (Diskin)	Q in cfs (Smith)	Q in cfs (Raj.& Mur.)	Q in cfs (Author)	Q in cfs (Measured)
1	0.132	0.068	0.077	0.071	0.072	0.077	0.070	0.071
2	0.200	0.150	0.160	0.158	0.150	0.160	0.160	0.159
3	0.231	0.204	0.211	0.208	0.200	0.213	0.210	0.213
4	0.274	0.280	0.294	0.298	0.275	0.294	0.288	0.290
5	0.310	0.348	0.358	0.373	0.344	0.367	0.372	0.375
6	0.348	0.436	0.447	0.472	0.425	0.454	0.463	0.470
7	0.400	0.566	0.582	0.622	0.550	0.586	0.612	0.608
8	0.456	0.730	0.728	0.805	0.700	0.748	0.786	0.774
9	0.492	0.840	0.840	0.930	0.800	0.855	0.910	0.890
10	0.512	0.990	0.900	1.010	0.864	0.920	0.950	0.930

6. Rajaratnam, N., and Muralidhar, D., "End Depth for Circular Channels,,, Journal of the Hydraulics Division. ASCE, Vol. 90, No. HY2, Proc. Paper 3828, March 1964, pp. 99-119.

7. Rohwer, Carl W., "Discharge of Pipes Flowing Partly Full," Civil Engineering, ASCE, Vol. 13, October, 1943, pp. 488-490.

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10. Van Leer, Blake, R., "The California Pipe Method of Water Measurement," McGraw-Hill Publishing Co., Inc., New York, N.Y., Vol. 89, August 3, 1922, pp. 190-192, and Vol. 93, August 21, 1924, p. 293.

APPENDIX II.-NOTATION

The following symbols have been adopted for use in this paper :

A	=	area of flow at the brink;
A_o, A_1, A_2	=	arbitrary constants;
D	=	inside diameter of pipe
D_c	=	hydraulic depth at the critical depth section:
g	=	acceleration due to gravity;
H_o	=	head at the top of the water surface at the brink;
	=	specific head at the brisk;
i	=	$\sqrt{-1}$,
log	=	natural logarithm;
Q	=	discharge;
r_o	=	radius of pipe;
S	=	half-width of water surface at the brink;
V	=	local velocity;
W	=	complex potential;
(x,y,z)	=	cartesian coordinates;
y	=	depth of flow;
y_c	=	critical depth;
$\bar{y}$	=	depth of center of gravity below water surface at the brink;
y_e	=	depth of flow at the brink;
Z	=	$x+iy$; complex variable;
$\propto$	=	function of y_e /D;
θ	=	angle of velocity vector with horizontal;
ϕ	=	velocity potential; and
ψ	=	stream function.

TABLE 1.- EVALUATION OF $\left[1 + \frac{1}{2}\left(\frac{\bar{y}}{H_o}\right) - \frac{1}{4}\left(\frac{\bar{y}}{H_o}\right)^2\right]$

No.	observed Q in cfs	observed $\frac{y_e}{D}$	$\frac{y_c}{D}$	$\frac{D_c}{D}$	$\frac{H_o}{y_e}$	$\frac{\bar{y}}{y_e}$	$\frac{\bar{y}}{H_o}$	$\left[1+\frac{1}{2}\left(\frac{\bar{y}}{H_o}\right)-\frac{1}{4}\left(\frac{\bar{y}}{H_o}\right)^2\right]$
1	0.071	0.132	0.182	0.127	0.86	0.410	0.477	1.18
2	0.159	0.200	0.274	0.196	0.86	0.415	0.482	1.18
3	0.213	0.231	0.315	0.228	0.86	0.415	0.482	1.18
4	0.290	0.274	0.374	0.277	0.87	0.415	0.477	1.18
5	0.375	0.310	0.427	0.323	0.90	0.415	0.460	1.18
6	0.470	0.348	0.480	0.373	0.91	0.418	0.460	1.18
7	0.608	0.400	0.551	0.446	0.94	0.420	0.447	1.17
8	0.774	0.456	0.625	0.534	0.96	0.420	0.438	1.17
9	0.890	0.492	0.677	0.605	0.99	0.425	0.430	1.17
10	0.930	0.512	0.685	0.617	0.94	0.430	0.457	1.18

Table - 2 - Comparison of calculated discharges by measured values

No	$\frac{y_e}{D}$	$\frac{H_o}{y_e}$	H_o ft	A ft^2	calculated Q in cfs	Measured Q in cfs
1	0.132	0.86	0.071	0.028	0.070	0.071
2	0.200	0.86	0.116	0.050	0.160	0.159
3	0.231	0.86	0.133	0.061	0.210	0.213
4	0.274	0.87	0.159	0.078	0.288	0.290
5	0.310	0.90	0.186	0.092	0.372	0.375
6	0.348	0.91	0.210	0.10[illegible]	0.463	0.470
7	0.400	0.94	0.250	0.130	0.612	0.608
8	0.456	0.96	0.292	0.155	0.786	0.774
9	0.492	0.99	0.325	0.170	0.910	0.890
10	0.512	0.94	0.320	0.179	0.950	0.930

The treatment is based on the assumption of irrotational flow inside the zone of the free overfall. The relationship is well confirmed by the experimental results published by Rajaratnam and Muralidhar. Comparisons have shown a close agreement between the proposed theory and the experimental results and represented a considerable improvement over previous methods. In addition, the excellent agreement between the computed and measured discharges shows that the assumption of irrotational flow is a reasonable one and the problem is well suited to analysis by potential theory. The paper is an addition to the literature on the theory of curvilinear flow.

APPENDIX I. — REFERENCES

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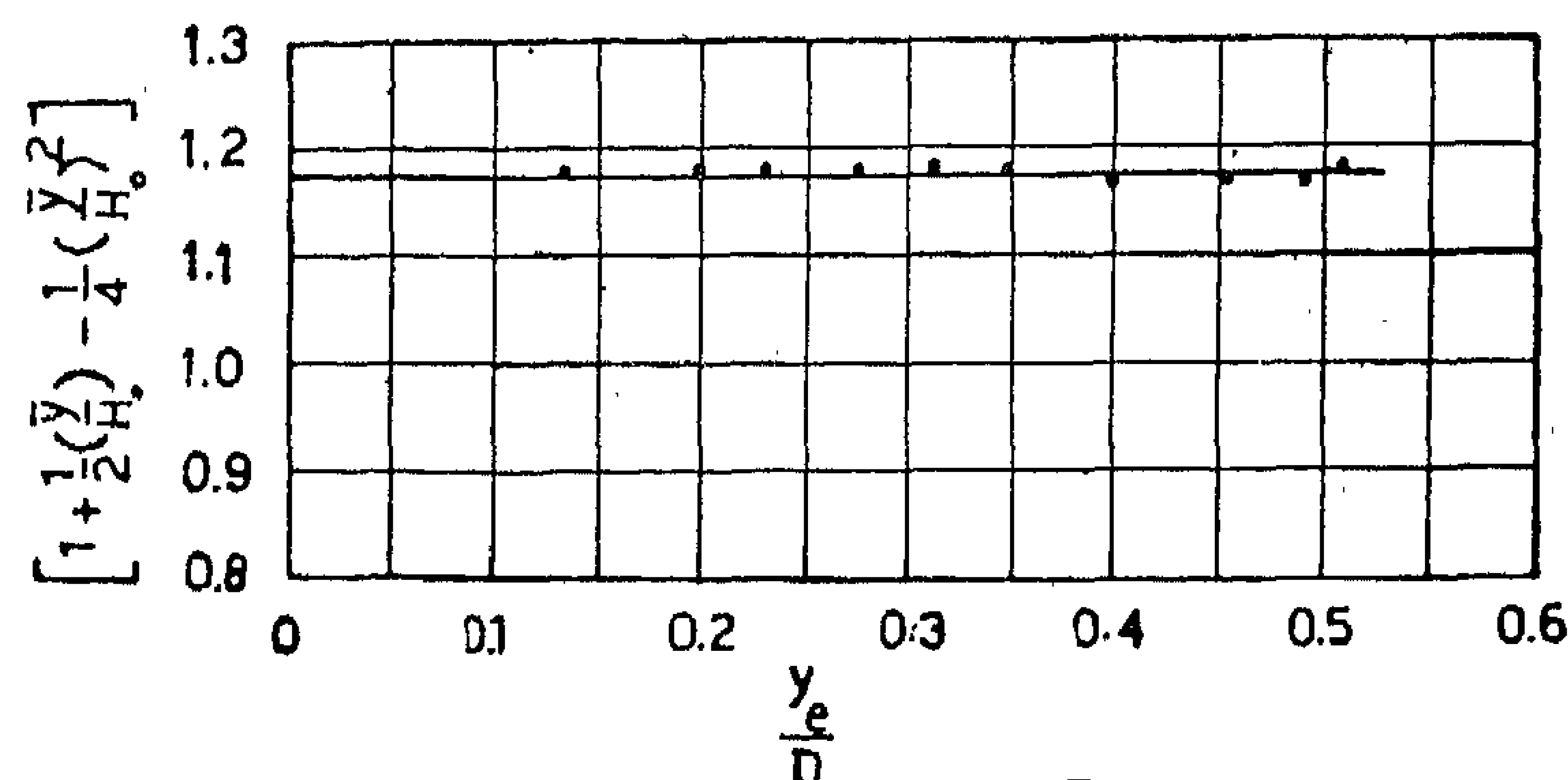


FIG. 3.-.RELATIONSHIP BETWEEN $\frac{y_e}{D}$ AND $\left[1+\frac{1}{2}(\frac{\bar{y}}{H_o})-\frac{1}{4}(\frac{\bar{y}}{H_o})^2\right]$

COMPARISON OF THEORY WITH EXPERIMENTAL RESULTS

The experimental results investigated by Rajaratnam and Muralidhar (6) are used to verify the proposed theory Table (2) shows a comparison between the measured discharges and the corresponding values predicted by Eq. 34. The relationship between the theoretical and measured discharges is illustrated in Fig. 4. It is obvious that the computed discharges agree extremely well with the measured values.

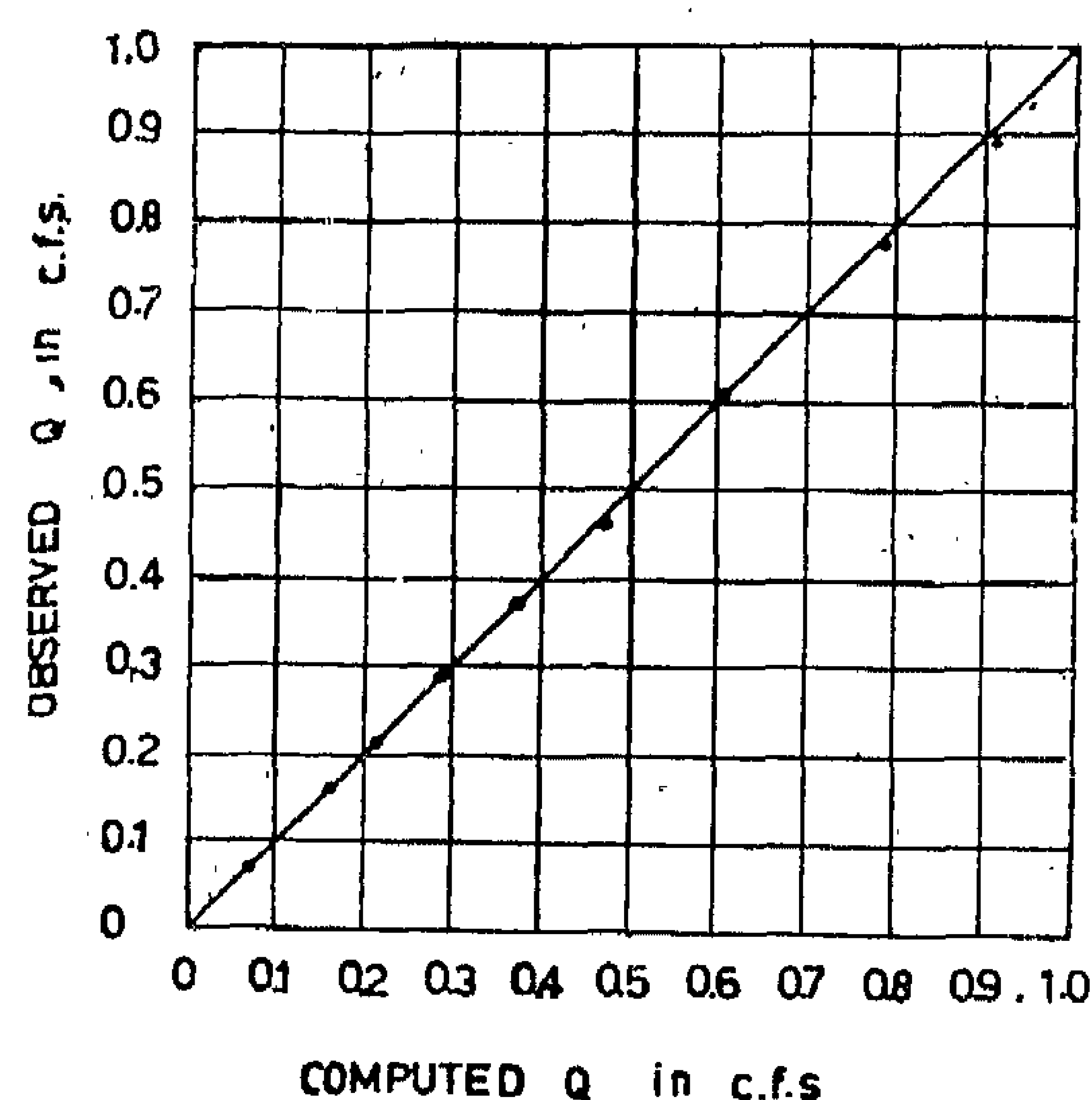


FIG. 4 -RELATIONSHIP BETWEEN THEORETICAL AN OBSERVED DISCHARGES

COMPARISON OF DISCHARGES COMPUTED BY DIFFERENT METHODS

A general comparison between the discharges resulting from using all methods presented by several investigators, is illustrated in Table 3. The discharges are computed by Eqs. 1,2,3,4,5 and 34 which are provided by Van Leer, Rohwer, Diskin, Smith, Rajaratnam and Muralidhar, and the author, respectively. Computed discharges are compared with the measured values published by Rajaratnaman and Muralidhar. It appears that the proposed theory shows better agreement with the measurements over the previous methods.

CONCLUSIONS

An analytical relationship is derived for computing the discharge of a partly flowing horizontal or slightly sloping pipe discharging freely into the air. The discharge has been theoretically shown in Eq. 34 to be dependent on the brink depth and the specific head at the end section.

$$Q = \tfrac{1}{2} A V_o + V_o \int_0^S y_o \left[1 + \tfrac{1}{2} \left(\frac{y_o}{H_o}\right) - \frac{1}{8} \left(\frac{y_o}{H_o}\right)^2\right] dz$$

or

$$Q = \tfrac{1}{2} A V_o + V_o \int_0^S y_o \, dz + \frac{V_o}{H_o} \int_0^S \left(\frac{y_o}{2}\right) y_o \, dz$$

$$\frac{V_o}{2H_o^{\,2}} \int_0^S \left(\frac{y_o}{2}\right)^2 y_o \, dz$$

(29)

$$\text{Since} \quad \int_0^S y_o \, dz = \tfrac{1}{2} A$$

$$\int_0^S \left(\frac{y_o}{2}\right) y_o \, dz = \tfrac{1}{2} A\bar{y}$$

$$\text{and} \quad \int_0^S \left(\frac{y_o}{2}\right)^2 y_o \, dz = \tfrac{1}{2} A\bar{y}^2$$

in which y is the depth of the center of gravity of the water area A below the free surface and A is the area of flow at the end section. Accordingly, Eq. (29) yields

$$Q = A V_o \left[1 + \tfrac{1}{2} \left(\frac{\bar{y}}{H_o}\right) - \tfrac{1}{4} \left(\frac{\bar{y}}{H_o}\right)^2\right]$$

(30)

The significance of Eq. 30 is examined in the light of the experimental results provided by Rajaratnam and Muralidhar (6). They conducted an experimental study on a galvanized metal pipe 8 in. inside diameter and 20 ft long. For each flow, the discharge and the brink depth were messured for a fully developed horizontal circular free overfall. Using the value of Q and y_e/D, the rest of the parameters shown in Table 1 can be computed.

For a circular section shown in Fig. 1

$$A = \frac{1}{8} (\beta - \sin \beta) D^2$$

or

$$A = \alpha D^2 \qquad (31$$

and

$$\frac{\bar{y}}{y_e} = \frac{2}{3\alpha} \left(\frac{D_e}{D}\right)^2 \left(\frac{D}{y_e} - 1\right)^{3/2} - \left(\frac{D}{2\, y_e} - 1\right.$$

(32)

in which A is the water area, D is the inside pipe diameter y_e is the brink depth, $\bar{y}$ is depth of center of gravity below free surface and α is a function of y_e /D. The geometric elements for circular sections are listed numerically by Chow (3) in Appendix A.

It is obvious from Table 1 and Fig. 3. that

$$\left[1 + \tfrac{1}{2} \left(\frac{\bar{y}}{H_o}\right) - \tfrac{1}{4} \left(\frac{\bar{y}}{H_o}\right)^2\right] = 1.175$$

(33)

Substituting Eq. 33 into Eq. 30 yields

$$Q = 1.175 \, A \, V_o$$

$$\text{Since} \quad V_o = \sqrt{2g \, H_o}$$

$$\text{and} \quad H_o = (H_1 - y_e)$$

$$\text{Thus} \quad Q = 1.175 \, A \sqrt{2g \, (H_1 - y_e)}$$

(34)

in which H_1 is the specific head at the brink, y_e is the brink depth and A is the water area at the brink section.

An examination of Eq. 34 shows that the estimation of the discharge requires measuring both y_e and H

$$\theta = \theta_o \left(1 - \frac{y}{y_o}\right)$$

$$\log_e \left(\frac{V}{V_o}\right) = \left(\frac{y}{y_o}\right) \log_e \left(\frac{V_1}{V_o}\right)$$

$$\frac{V}{V_o} = \left(\frac{V_1}{V_o}\right)^{y/y_o} \qquad (19)$$

where y is the water depth in the vertical. The evaluation of the discharge can be found from

$$Q = \iint_A V \cos \theta \, dA \qquad (20)$$

where A is the water area at the end section. Since θ_o is found to be approximately 15° from the equation of the upper surface of the free-falling nappe proposed for use by Blaisdell (2) for free overfall, thus

$$0.97 \angle \cos \theta \angle 1.0$$

Hence, the discharge is approximately expressed as

$$Q = \iint_A V \, dA \qquad (21)$$

$$\text{or} \qquad Q = 2 \int_0^S \int_0^{y_o} V dy \, dz$$

where S is half of the top width of the water surface. Substituting Eq. 19 in Eq. (21) produces

$$Q = 2 \int_0^S \int_0^{y_o} V_o \left(\frac{V_1}{V_o}\right)^{y/y_o} dy \, dz \qquad (22)$$

Integration with respect to y is estimated as follows :-

$$(18) \int_0^{y_o} V_o \left(\frac{V_1}{V_o}\right)^{y/y_o} dy = y_o \frac{(V_1 - V_o)}{\log_e V_1/V_o} = y_o \frac{(V_o - V_1)}{\log_e V_o/V_1}$$

(23)

since $0 < \frac{V_o}{V_1} < 1$, the quantity $\log_e \frac{V_o}{V_1}$ is expanded approximately in the form

$$\log_e \left(\frac{V_o}{V_1}\right) = 2 \left(\frac{\frac{V_o}{V_1} - 1}{\frac{V_o}{V_1} + 1}\right) = 2 \left(\frac{V_o - V_1}{V_o + V_1}\right)$$

which is substituted in Eq. 23 to give

$$\int_0^{y_o} V_o \left(\frac{V_1}{V_o}\right)^{y/y_o} dy = y_o \left(\frac{V_o + V_1}{2}\right) \qquad (24)$$

The introduction of Eq. 24 into Eq. 22 yields

$$Q = \int_0^S y_o (V_o + V_1) \, dz \qquad (25)$$

Since the pressure is atmospheric on the free surfaces of the nappe, it follows that

$$V_o = \sqrt{2g H_o} \qquad (26)$$

$$V_1 = \sqrt{2g (H_o + y_o)} \qquad (27)$$

It is obvious that V_1 is a function of z since

$$r_o^2 = Z^2 + (y_o + a_o)^2$$

Thus, Eq. 25 becomes

$$Q = V_o \int_0^S y_o \, dz + \int_0^S y_o \sqrt{2g (H_o + y_o)} \, dz$$

or

$$Q = \tfrac{1}{2} A V_o + \sqrt{2g H_o} \int_0^S y_o \left(1 + \frac{y_o}{H_o}\right)^{1/2} dz$$

When y_o/H_o is less than 1.0 as found experimentally, the quantity $(1 + y_o/H_o)^{1/2}$ can be expanded. Eq. 28 becomes

Differentiating W with respect to Z yields

$$\frac{dw}{dz} = Ve^{-i\theta} \qquad (8)$$

in which V is the magnitude of the velocity vector, and is its inclination. The natural logarithm of Eq. (8) gives

$$\log_e \left(\frac{dw}{dz}\right) = \log_e V - i\theta \qquad (9)$$

Since the quantities $\log_e V$ and θ must satisfy the Cauchy-Riemann conditions, it follows that

$$\frac{1}{V}\frac{\partial V}{\partial X} = -\frac{\partial \theta}{\partial y} \qquad (10)$$

and

$$\frac{1}{V}\frac{\partial V}{\partial y} = \frac{\partial}{\partial x} \qquad (11)$$

By differentiating Eqs. 10 and 11 and adding, one obtains

$$\frac{\partial^2 \theta}{\partial x^2} + \frac{\partial^2 \theta}{\partial y^2} = O \qquad (12)$$

which indicates that the function θ (x,y) must satisfy the Laplace equation.

Multiplication of Eq. 10 by dx and Eq. 11 by dy and adding yield.

$$\frac{dV}{V} = \frac{\partial \theta}{\partial x}dy - \frac{\partial \theta}{\partial y}dx$$

which is integrated to produce

$$V = V_o \exp \int_{(x_o,y_o)}^{(x,y)} \left(\frac{\partial \theta}{\partial x}dy - \frac{\partial \theta}{\partial y}dx\right) \qquad (13)$$

in which V_o is the velocity at the point (x_o, y_o) ant V is the velocity at the point (x,y).

Eqs. 12 and 13 provide the governing differential equations for the magnitude of the velocity vector V and its inclination θ.

The second step in the analysis is to find a solution for Laplace equation to provide the function θ. Consider Fig. 2 in which the origin is taken at a point on the free water surface and at the pipe end section. The x-axis is perpendicular to the end section and the y-axis is directed vertically downwards and passes through the center of the pipe. The z-axis is perpendicular to the x-y plane and lies in the end section of the pipe.

Taking the solution for θ in the form

$$\theta = A_o + A_1 x + A_2 y \qquad (14)$$

determined from the associated boundary conditions defined as follows :

$$\theta = \theta_o ; V = V_o \quad \text{at } (o,o) \qquad (15a)$$

$$\text{and } \theta = O ; V = V_1 \quad \text{at } (o,y_o) \qquad (15b)$$

Integrating Eq. 13 from (0,0) to (O,y_o) in the form

$$\log_e \frac{V}{V_o} = \int_{(o,o)}^{(o,y_o)} \left(\frac{\partial \theta}{\partial x}dy - \frac{\partial \theta}{\partial y}dx\right)$$

in which Eq. 14 is substituted to obtain

$$\log_e \left(\frac{V}{V_o}\right) = A_1 y \qquad (16)$$

Introduction of the boundary values from Eqs. 15 into Eqs. 14 and 16 yields

$$A_o = \theta_o \qquad (17a)$$

$$A_1 = \frac{1}{y_o}\log_e\left(\frac{V_1}{V_o}\right) \qquad (17b)$$

and

$$A_2 = -\frac{\theta_o}{y_o} \qquad (17c)$$

Thus, the distribution of the velocity and its inclination across any vertical in the end section are expressed as

rallel flow which is applicable to gradually varied flow. Chow also mentioned that the flow at the brink is actually curvilinear because the curvature there is pronounced. In addition, the pressure at the brink is atmospheric only at the surface and the bottom and having a significant value in the zone between depending on the convergence of the streamlines.

Thus, none of the previous studies provides information concerning the application of the potential thery at the brink. This paper is believed to be the first to represent an analysis based on the potential theory technique.

THEORETICAL ANALYSIS

The converging flow at the free overfall from a pipe flowing partly full is shown in Fig. 1. It represents a case well suited to analysis by potential theory. The flow at the end section is rapidly varied flow where the curvature of the streamlines is significant. In rapidly accelerated flow, viscous forces become nonsignificant with respect to pressure and inertia forces. As a result, the fluid is assumed to be inviscid and incompressible and the flow irrotational. Based on these assumptions, a satisfactory theoretical solution of this problem has been established.

The analysis herein is obtained without any assumptions regarding the distribution of the streamline curvature as many investigators are used to do for the analysis of rapidly varied flow. In previous studies of the curvilinear flow problems, the curvature is assumed to increase either linearly or exponentially from the channel bed to the curved flow surface.

Analysis developed herein starts with considering the stream function ψ and the velocity potential ϕ which are harmonic functions of the x-and y-coordinates in the physical plane. The complex potential W, defined as,

$$W = \phi + i \psi \tag{6}$$

is an analytic function of Z, in which Z is defined as

$$Z = x + iy \tag{7}$$

The Z-plane is defined by the geometry of the nappe in the x-y plane as shown in Fig. (2).

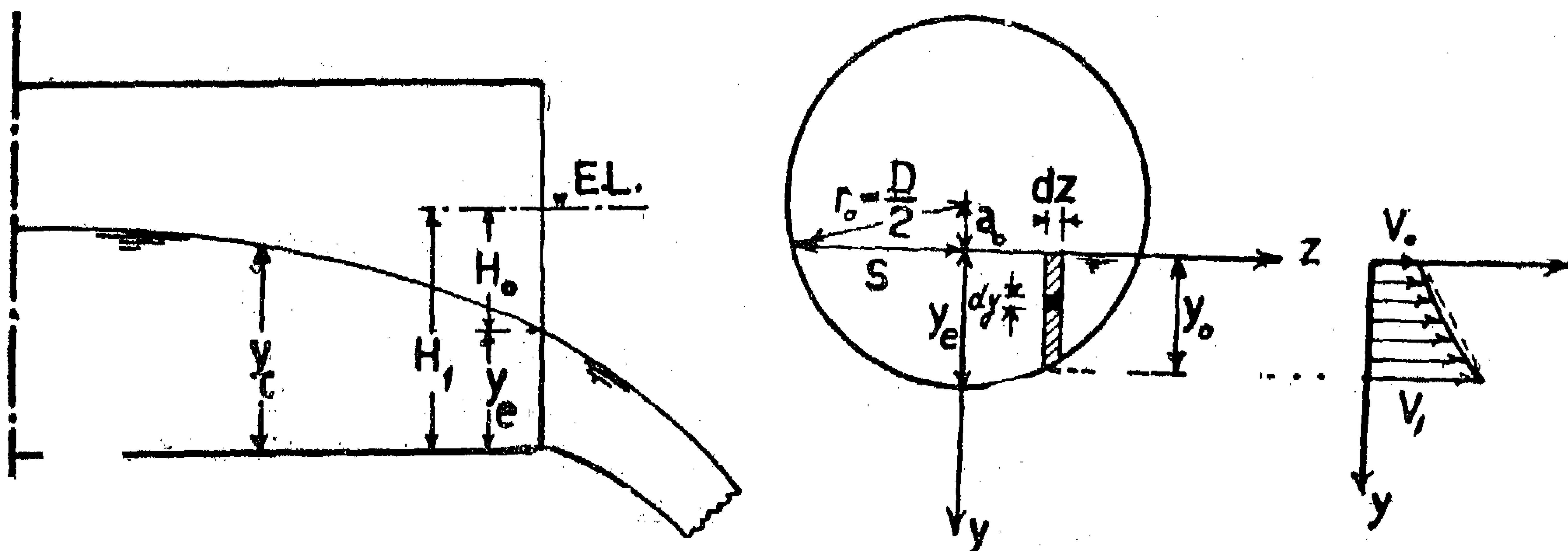


Fig. 2. Definition sketch for velocity distribution at the Brink.

that it occurs at about 3 y_c to 4 y_c upstream the brink section. The analysis is based on the parallel-flow assumption.

In 1943, Rohwer (7) investigated experimentally the flow rate in circular channels freely discharging. He gave the following expression

$$Q = 8.20\, D^{0.62}\, y_c^{1.82} \qquad (2)$$

in which all terms are in fps units.

In 1961, Diskin (4) developed equations regarding the end depth for exponential and trapezoidal channels. Later in 1963, he continued his analysis for circular channels through application of the momentum theorem assuming atmospheric pressure across the brink section. He recommended the following relationship for practical computation of the discharge

$$\frac{Q}{\sqrt{g\, D^{2.5}}} = 1.82 \left(\frac{y_c}{D} \right)^{1.96} \qquad (3)$$

He mentioned that a measurement using the depth at some section a short distance upstream the end section may be preferred.

In 1962, Smith (9) investigated the relationship between the discharge and the brink depth of a freely discharging pipe. He established his analysis through application of the momentum theorem on a free body of water between the critical depth section and a section downstream from the brink. He assumed that the internal pressure along any vertical section through the nappe beyond the brink is atmospheric. For practical use, he provided a graph based on his experimental results for the estimation of the discharge. Later, from his experimental studies the following relation was given

$$Q = 8.17\, D^{0.66}\, y_c^{1.84} \qquad (4)$$

in which all terms are in fps units. Eq. 4 is used for smooth and horizontal pipes. During some of his experiments, the free overfall does not seem to have been a developed one.

In 1962, Advani (1) derived the end depth discharge relationship for circular channels based on the principle of momentum. He assumed zero pressure at the brink section.

In 1964, Rajaratnam and Muralidhar (6) represented an extensive study for the end tepth probelm in circular channels. For a fully developed horizontal circular overfall, it was found that the ratio of the end tepth to the corresponding critical depth is 0.725. For estimation of the discharge they proposed the following equation

$$Q = 8.72\, D^{0.66}\, y_e^{1.84} \qquad (5)$$

with Q in cubic feet per secont and y_e and D in feet. Eq. 5 was obtained by plotting all available experimental results along with the calculated values by Van Leer and Rohwer equations.

They noticed also that the pipe roughness is not significant.

It is obvious that most of the previous solutions are obtained through application of the momentum theorem assuming atmospheric pressure at the brink section. Chow (3) has indicated that the determination of the critical depth by this approach is based on the assumption of pa-

parallel flow which is an approximate application to gradually varied flow.

In fact, a satisfactory general solution of this problem has not yet been obtained. It is obvious that the flow at the brink is actually curvilinear and well suited to analysis by potential theory.

The objective of this study is to derive a basic potential flow solution for the problem in a convenient and usable form to compute the discharge in terms of the end depth and specific head at the brink.

Notation - Letter symbols adopted for use in this paper are defined where they first appear and are arranged alphabetically in Appendix II.

PREVIOUS INVESTIGATIONS

The earliest experimental study of the brink depth in circular channels, shown in Fig. 1, for measuring the discharge was represented by Van Leer (10)[2] in 1924, at the University of California, Berkeley. For convenient utilization of his results, diagrams were published. Later. his experimental results were summarized and given by King (5) in the form

$$Q = 8.69\, D^{0.60}\, y_e^{1.88} \qquad (1)$$

in which Q is the discharge in cubic feet per second, D is the inside diameter of the pipe in feet, and y_e is the end depth in feet. Van Leer conducted his experiments on pipes ranging from 3 to 10 inches in diameter. His study was limited to horizontal pipes with length exceeding six times its diameter and flowing partially filled.

In 1936, Rouse (8) studied the brink depth in a two-dimensional free overfall. He found that for small slopes the computed critical depth y_c is about 1.4 times the brink depth, or $y_e = 1.4\, y_c$, and

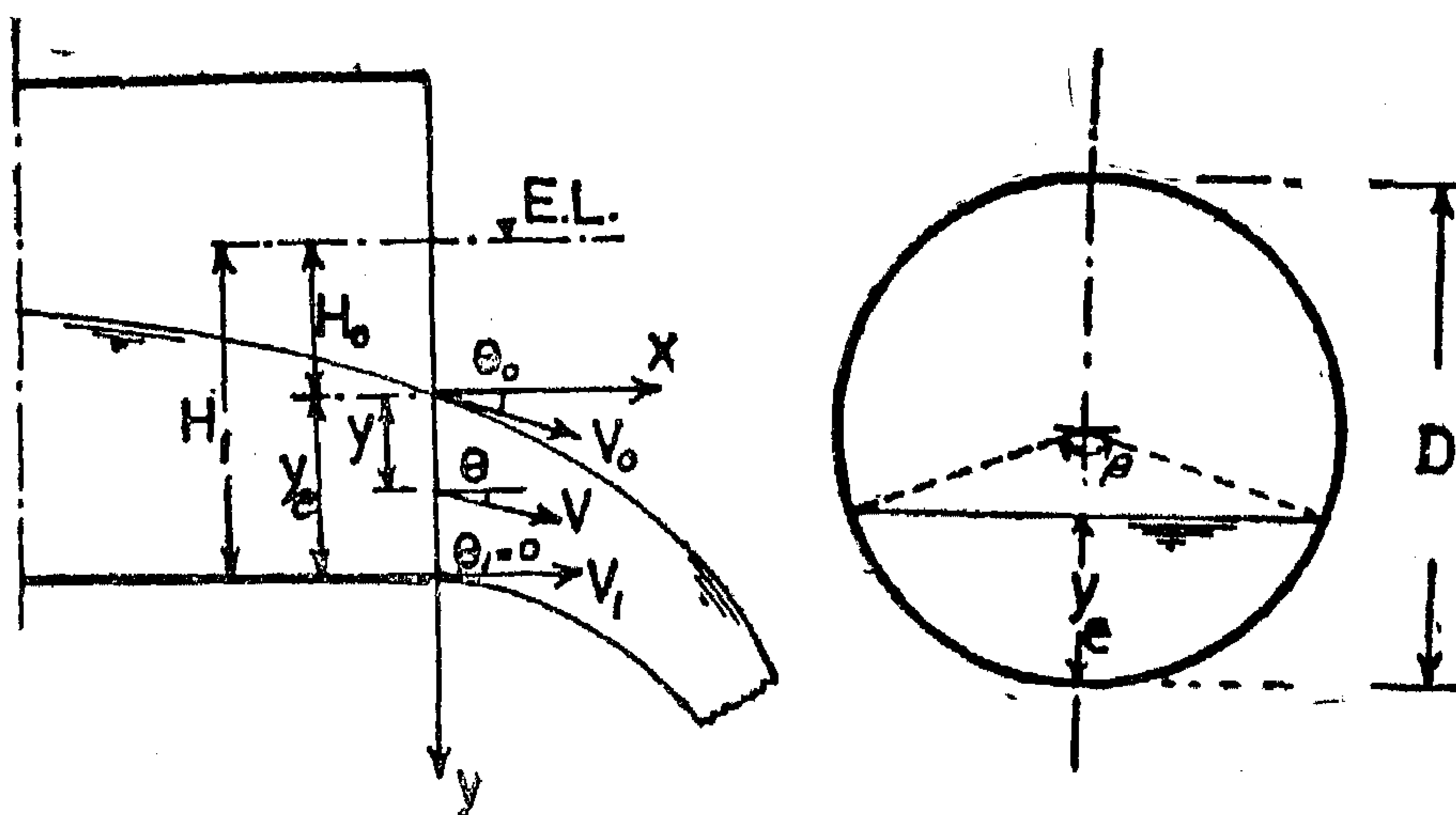


Fig. 1. Definilion sketch for circular flow and Brink Depth

2 — Numerals in parentheses refer to corresponding items in Appendix 1, References.

END DEPTH-DISCHARGE RELATIONSHIP IN CIRCULAR CHANNELS

By

Dr. MOHAMED HAMDY EL-KATEB*

SYNOSIS

An analytical relationship is derived for computing the discharge of a partly flowing horizontal or slightly sloping pipe discharging freely into the air. The flow rate is found to be a function of the end depth and specific head at the section of the brink. The treatment is based on the potential theory because the flow at the brink is actually curvilinear and rapidly accelarating. Previous investigations are based on experimental results and the application of the momentum theory.

Discharges computed by the proposed and existing relations are compared with flow measurements. The comparison shows that the proposed relationship agrees well with the experimental values. It indicates that a high order of accuracy is achieved, while the previous methods do not have such accuracy and sometimes result in large differences from the measurements.

The derived equation provides more information to all laboratory technicians and field engineers concerned with flow measurements especially in the field of tile drainage. The outlet of the tile drain is considered as a measuring device. The same situation occurs at a free outlet from a pipe culvert flowing partly full. In all cases, the discharge can be accurately, predicted by the derived relationship.

INTRODUCTION

The brink depth in a freely discharging pipe offers an important subject as a measuring device for the estimation of the discharge. Experimental tests and theoretical attempts have been made by several investigators introducing rational formulas. The discharge is expressed in the form of various empirical equations having the end depth and the pipe diameter as parameters. It has been shown that the end depth for the circular free overfalls is about 0.725 times the corresponding critical depth. This result is based on experimental studies and analytical treatments which have been achieved by application of the momentum theorem. A free body diagram was considered between the section at the critical depth and the section at the brink. The analysis is based on the assumption of

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anle for static pressure readin. In the present investigation, this specified angle was found to be 43° over a range of Reynolds number from 5.8x10 to 8.25x10 based on the cylinders diameter. This value is in close agreement with the value of 24° found by Hutton over a range of Reynold's number between 6 x 10 and 2 x 10

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* * *

was from 30° to 45° and the range of Reynolds number explored varied from 5.8 x 10 to 8.25 x 10 based on the cylinder's diameter and local velocity of flow. In this wide range of Reynold's number, the central angle 0 which gave a dynamic pressure coefficient KQ of zero value was found to be 43° throughout the full range. Figure (7) shows the corresponding results.

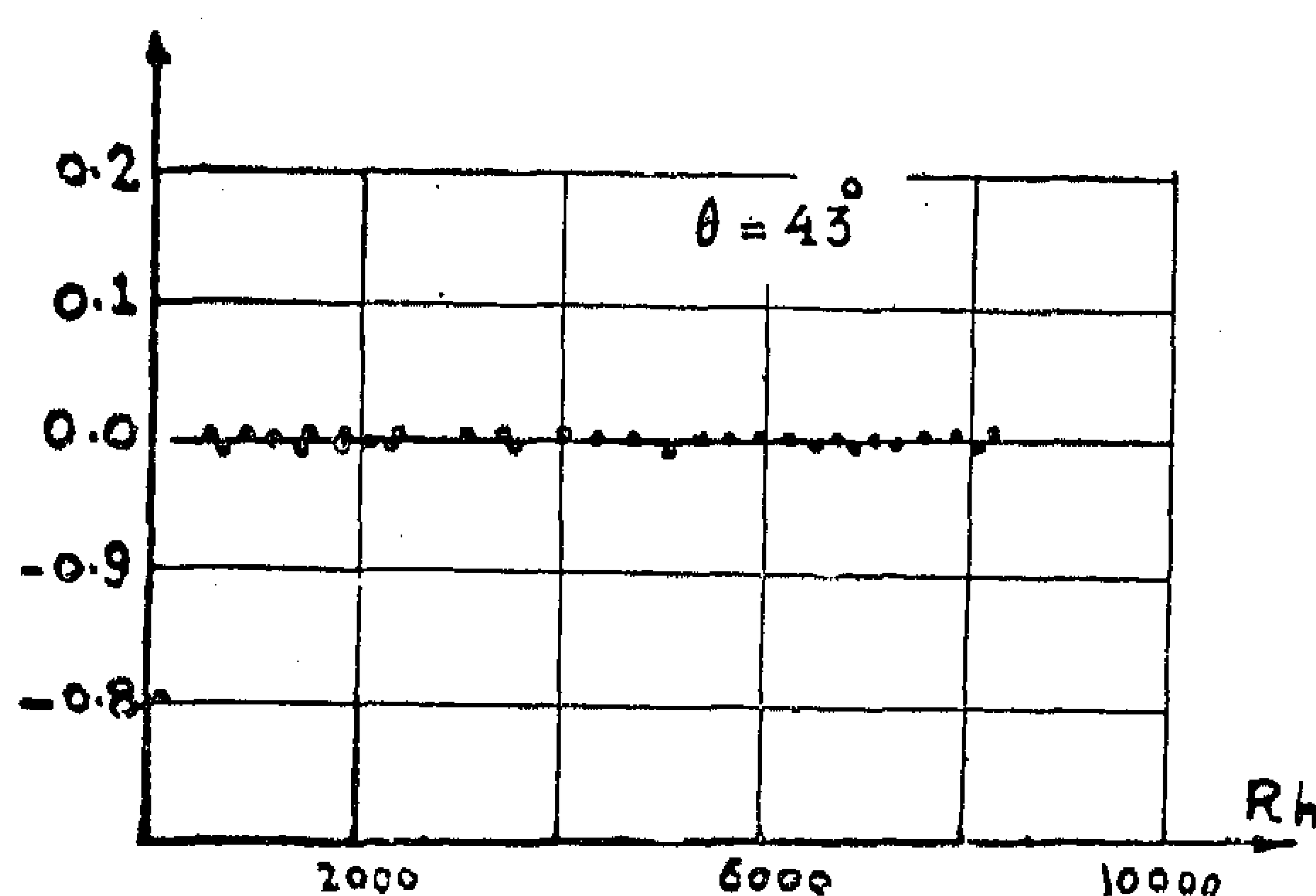


FIG. (7)

This value of 0 compares favourably with the corresponding value obtained by Hutten (1954) for a pitot vylinder diameter and for which he found a value for 0 of 42° in the range of Reynolds number from 6 x 10 to 2 x 10 based on the cylinders diameter.

On the other hand, the experiments carried out in the St. Antony Falls Hydraulies Laboratory showed that the total head coefficient for a long pitot cylinder is the same as that for a standad pitot tube under the same conditions, but considerable errors in the static head readings were recorded. This expected since the pressure gradient around the cylinder is very steep in the zone around the point of zero dynamic pressure. The St. Antony falls experiments recorded an error of 5% in the pressure reading corresponding to an error of 1.0° in the location of the central angle Q. Accordingly, the use of a single hole pitot cylinder for measuring velocities has the advantage of eliminating the possible error in the location of the static pressure hole which is not possible with a two holed pitot cylinder.

Rearding the viscous effects on the readings of the present pitot cylinder, Miss Baker (1922) from experiments on the use of total head pitot tubes for measuring wind velocities showed that the velocity of flow can be found accurately from the difference between the pitot reading and the static pressure reading opposite to its mouth provided that where is the radius of the pitot opening. For lower values of Miss Baker found that the viscosity effect shows itself in the form of a pressure rise around the mouth and the recorded velocities will be greater than the actual values. However, in the present investigation the value of varied between 68 and 900 which are far outside the range of viscosity effect.

Schaubeur and Dryden (1935) on the other and found no effect of the turbulence on the pitot tube readings and it is expected therefore, that turbulence hardly had any effect on the present reading obtained by the single hole pitot cylinder.

CONCLUSIONS

The use of a two holed pitot cylinder for velocity measurements has the disadvantage that a very small error in the location of one hole on the cylinder's perimeter will result in a considerable error in the central angle. Since the uressure gradient around the cylinder is very steep in the zone around the point of zero dynamic pressure, the error in the central angle will have a serious effect on the velocity reading.

To avoid that, a single hole pitot cylinder may be used.

The hole can be directed to face the stream lines for total head readin and then the cylinder is rotated by means of a protractor throuh the specified central

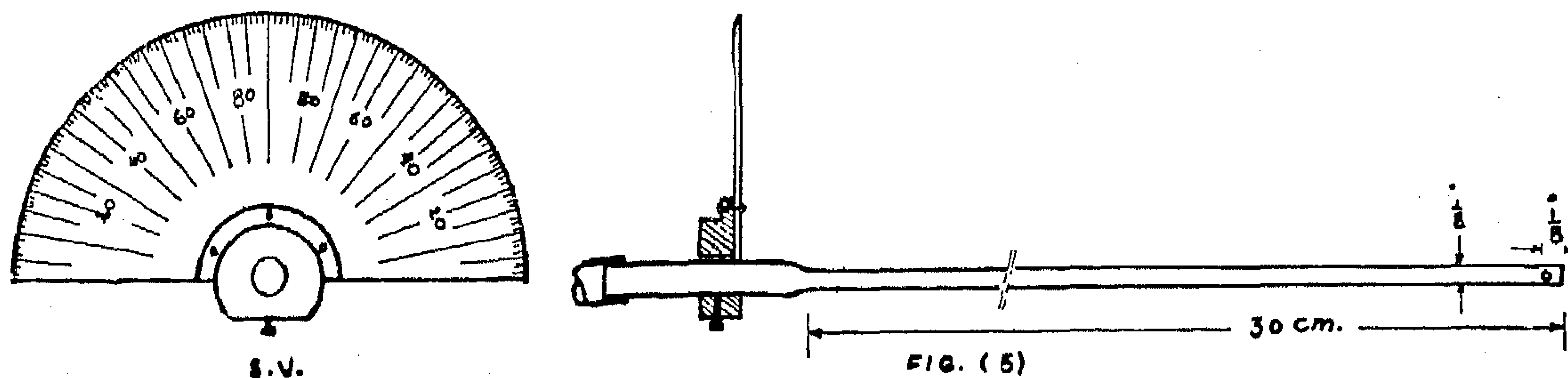


FIG. (6)

The pitot cylinder was inserted in a uniform flow through a rectangular channel to various depths of the flow and was claibrated against a standard pitot tube inserted at the same depths.

The static pressure was recorded at these depths through pizometric openings in the side of the chanel.

To obtain reliable results, the pitot tube was inserted at the various depths such that its pressure holes in each time were at the point as that which the cylinder hole will occupy and in the same time lie in the same cross section with the pizometer opening in the channel side.

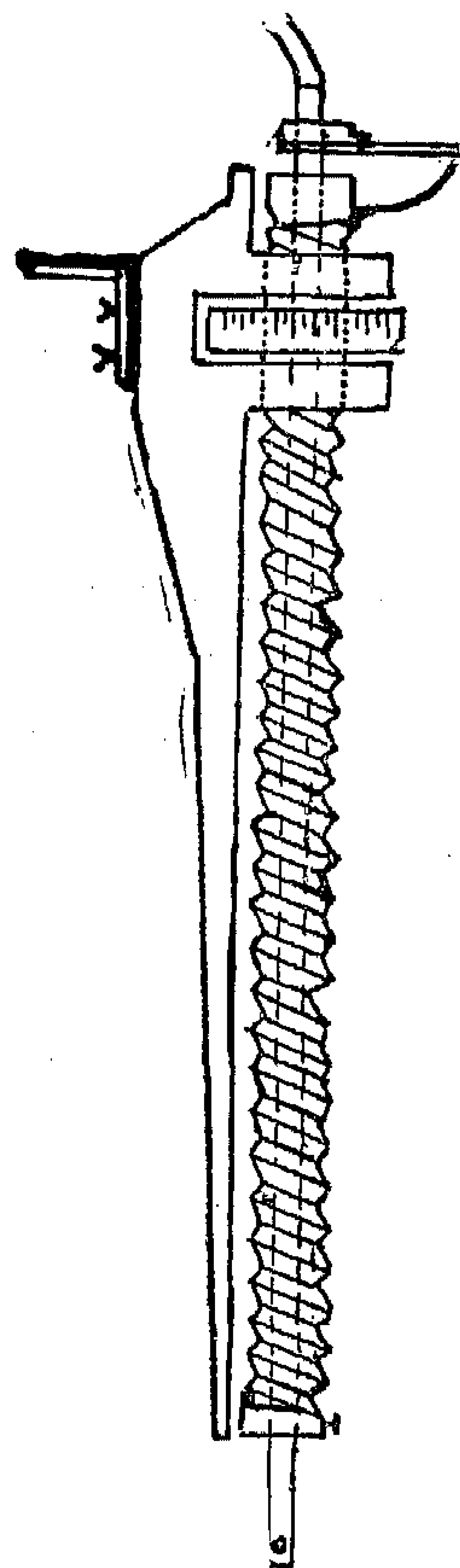
For these various depth, the total and static heads reading for the pitot cylinder were recorded together with the corresponding readings of the pitot tube and the side pizometer on a manometer .

For total head readings by the pitot cylinder, an dto locate the cylinder hall ficing the stream lines, the instrument was rotated through an arbitrary position by the aid of the protractor and the pressure was recorded. The instrument was recorded. The instrument was then turned in the opposite direction until the same pressure reading was obtained. The bisector of the angle between the two positions gave the right position for the hole. The process was repeated and in the majority of the experiments consistent results were noticable.

Regarding the static pressure reading, the central angle 0 explored in the investigation varied from 30° to 45° for each position considered in the investigation. The pressure reading for each angle was recorded and the angle that gave a zero dynamic pressure coefficient KQ was determined. Both of the pitot cylinder and the refrence pitot tube were carried by the micrometer gauge shown in figure (6).

EXPERIMENTAL RANGE AND RESULTS

The experimental range explored in the present investigation was relatively wide. The range for the central angle Q


FIG. (6)

It follows therefore, that the pressure distribution in all regions of the flow can be determined, once the flow pattern is know.n

For steady irrotational flow around a frictionless cylinder of infinite lengtyh, the velocity Ve at any point on the cylinder premiter with a central angle 0 is equal to 2 Vo sin Q. Therefore, equation (1) can be written as :

Consequently, the point with a zero dynamic pressure lies at a central angle 0 such that :

1 — 4 sin 0 — 0

That is to say, it lies at a central angle 0 = 30°

For such case of steady irrotational flow, pressure distribution around the clyinder is independent of the actual linear scale, velocity, fluid density or pressure gradient. The corresponding pressure distribution around the cylinder is shown in figure (2) an dthe corresponding flow pattern is shown in figure (3).

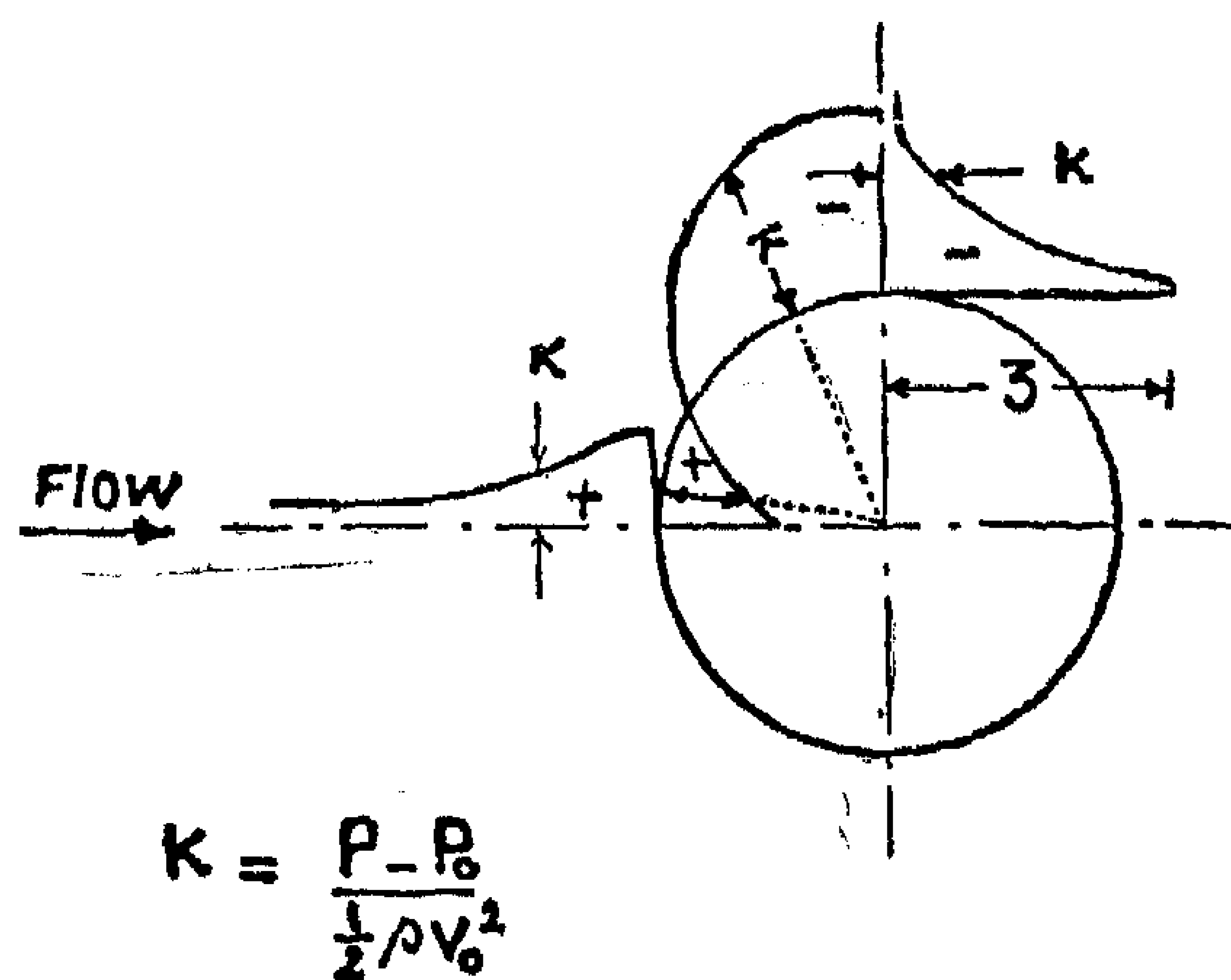


FIG. (2)

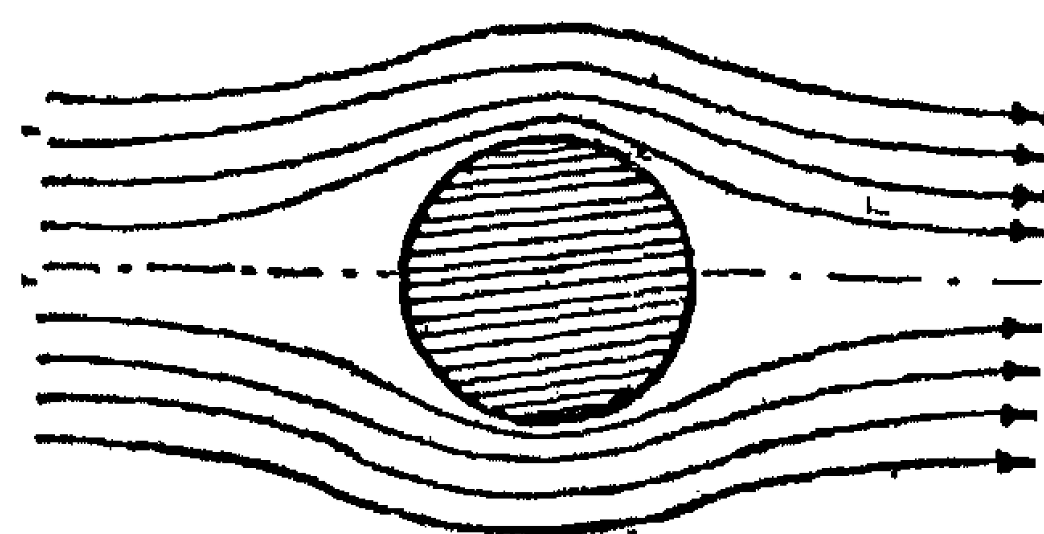


FIG. (3)

For rotational flow, on the other hand, fluid particular loose a part of their kinetic energy due to friction on the cylinder surface, and conseuently the flow at the rear of the cylinderieal strut will be characterized by a rapid decrease in the velocity, which results in separation from the boundary as shown in figure (4).

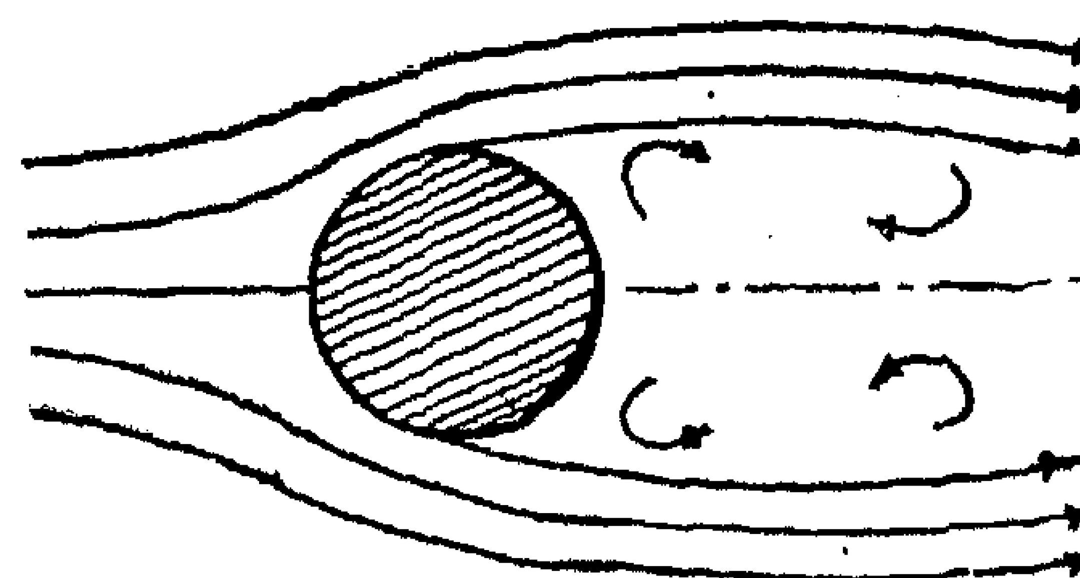


FIG. (4)

However, equation (2) still serves as a basis for pressure evaluation in the zone of increasing velocities around the cylinder, since in this zone on the upstream side of the cylinder, the flow pattern and the corresponding pressure distribution are very close to the conditions of irrotational flow. Conseuently, equation (2) can be modified to :

where Ke denotes the dynamic coefficient of a hole at a central angle 0. It is expected according to the above reasoning that KO will depend only on the central angle Q. The point of zaro dynamic pressure will lie at an angle Q that makes Ko in equation (3) equal to zero. The problem now is reduced to one of finding experimentally such an angle.

EXPERQIMENTAL STUDY

The single hole pitot cylinder used in the present investigation was a long stainless steel tube external diameter and distance of ⅛ (one diameter) from the tip. The cylinder was provided with a protractor at the other end for directional measurements, (figure 5).

VELOCITY MEASUREMENTS BY A SINGLE HOLE PITOT CYLINDER

by

Dr. ALY ISMAIL EL-GAWHARY,*

INTRODUCTION

A point cylinder has the advantage over a pitot tube that it can be inserted through the conduit where velocity surveys are to be made with a comparticely simple small tappings tappings, Also, di-rectional measuremenus can be made if required.

A common pitot cylinder usually has two holes, one is made facing the direction of flow for measuring fthe total head, and the other hole is drilled in the cylinder at such an angle to give the static head reading (figure 1). However, it is difficult to drill the two holes in the workshop at the exact necessary angle 6 because an error o f 0.10 mm for example in the location of one hole on the perimeter of a a diameter pitot cylinder will lead to an error of + (30 42) in the central angle 0. Due to the steep pressure gradient in the zone around the static head hole, such an error in the central angle will result in a considerable error in the pressure head and conseucntly in the velocity reading.

To overcome this disadvantage, a single hole pitot cylinder can be used and could be directed with the hole facing the stream lines for total head readings. and then it could be rotated by means of a protractor through the necessary angle to give static pressure reading. This means that for such type of pitot cylinder, two reading instead of one are required to get the velocity at each point.

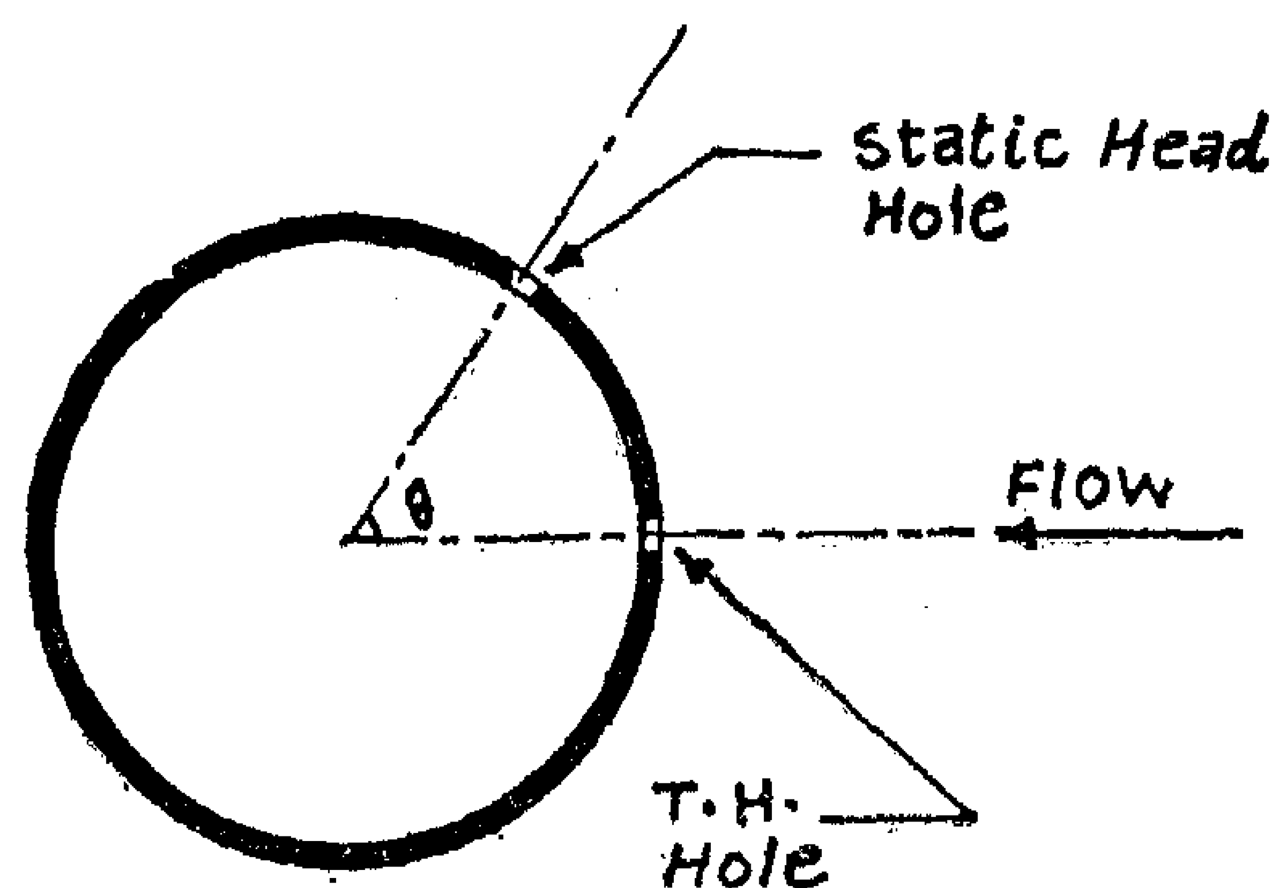


FIG. (1)

However, this disadvantage is outweighted by obtaining more accurate velocity readings, aince the hole could be rotated by means of a protractor to the specific central angle with uncertainity of not more than

was provided with a single hole mm at a

Theoritical considerations

For a steady irrotational flow, the sum has the same magnitude at all points along a given stream line, where is the fluid density, v is the flow velocity and p is static pressure. Therefore :

If Vo and Pe denote the velocity and pressure at refence point, where the flow is essentially uniform, the abocve equation can be written in the dimensionless form :

where V and p denote respectively the velocity and pressure at any point in the flow.

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المؤتمر العربي الأول لكهربة الريف

قامت الهيئة العامة لكهربة الريف بالاشتراك مع اتحاد المهندسين العرب بتنظيم المؤتمر العربى الأول لكهربة الريف الذى عقد فى القاهرة خلال المدة من ١١ — ١٣ مايو ١٩٧٤ تحت رئاسة السيد المهندس أحمد سلطان اسماعيل وزير الكهرباء بجمهورية مصر العربية .

وقد شاركت كل من الأردن وسوريا والعراق ولبنان وليبيا فى أعمال المؤتمر وبحوثه ، كما دعى الى المؤتمر وفود من الدول الافريقية والآسيوية والأوربية ، ساهمت بصورة ايجابية فى المناقشات وعرض خبراتها فى هذا المجال . وقد نوقشت خلال جلسات المؤتمر العديد من البحوث والدراسات شملت عرض تجربة جمهورية مصر العربية والدول العربية فى هذا المجال كذا الآثار الاقتصادية المترتبة على ادخال الكهرباء الى الريف وتأثيرها على التقدم الزراعى وتطوير الصناعات البيئية والحرفية . كما قدمت بعض الدراسات لانتاج المهمات الكهربائية محليا على أسس اقتصادية وتكنولوجية سليمة .

وقد ألقى السيد/ المهندس أحمد سلطان اسماعيل وزير الكهرباء بجمهورية مصر العربية كلمة اشاد فيها بالمشروع من الناحية السياسية والاقتصادية والاجتماعية كما أثنى على الجهود البناءة والتى تبذل فى المشروع وتنفيذه على خير وجه والتى جاء فيها « الطاقة الكهربائية دعامة من دعائم التنمية الاقتصادية والاجتماعية ، وتعتبر أساسا لقيام المشروعات الصناعية والزراعية ومشروعات الخدمات والمرافق العامة ، وأن عبء التقدم والبناء يقع أساسا على توفير الطاقة الكهربائية ورغم أن الريف المصرى كان دائما مصدر الخيرات التى أودعها الله فيه ، الا أنه عانى فى الماضى الكثير من الحرمان وبقى طويلا فى زوايا النسيان ، فكان ادخال الكهرباء فى القرى والحال كذلك أمرا يبدو فيما مضى بعيد المنال حتى ثورة ٢٣ يوليو ، فأولت المشروعات الكهربائية اهتماما كبيرا وعملت على تعميم استخدامات الكهرباء فى القرى اعترافا من الدولة بدور القرية المصرية التى كانت ولا زالت المورد الرئيسى للقوى البشرية ومصدر الحاصلات الزراعية ومحاصيل التصدير ، فكانت أساس قوتنا وصمودنا اقتصاديا وعسكريا » .

فأصبح « مشروع كهربة الريف » فى مصر من الموضوعات التى تحظى باهتمام كبير على المستوى السياسى والشعبى والحكومى ، وهو يستهدف أساسا كهربة القرية المصرية وليس انارتها فقط ، بمعنى أن يكون توصيل التيار الكهربائى الى القرية فضلا عن انارتها ، هادفا الى توصيل الخدمات الاعلامية وفتح مجالات كثيرة للتصنيع وخاصة الصناعات البيئية والحرفية وتشغيل آلات الرى والزراعة بالكهرباء بما يحقق ثروة اقتصادية واجتماعية حقيقية فى الريف . كما أن كهربة القرية ستحدث تطورا شاملا ، وسيمس هذا التطور بلا شك جوانب الحياة اليومية لسكان الريف كما سيؤثر بالزيادة فى اقتصاديات القرى فى كل من نواحى الانتاج الزراعى والصناعى ، وفى خلق العناصر البشرية المتطورة وربط القرية بعجلة الحضارة والتقدم ، وفى الحقيقة فان استخدام الكهرباء فى الريف يمثل جواز المرور للوصول بالقرية الى آفاق عالمنا المعاصر والى مجتمع الكفاية والعدل .

وقد ألقى السيد/ المهندس عبد العزيز عبد النبى المقرر العام للمؤتمر ورئيس الجهاز التنفيذى للهيئة العامة لكهربة الريف بكلمة قال فيها . « أن وصول القرية الى المستوى الحضرى ضرورة من ضرورات التنمية وعلينا كما يقول السيد الرئيس فى ورقة أكتوبر « ونحن نواجه مشكلات الحياة اليومية أن نتذكر دائما هذه الحقيقة وأن ندرك أن الرخاء يحتاج منا الى عمل كثير وطويل وشاق . والسبيل الأساسى لمواجهة هذا كله هو الارتفاع السريع بمعدلات التنمية لما نحققه من تنمية فى عام يزيد من قدراتنا فى العام التالى وبذلك فان هدف الارتفاع بمعدلات التنمية الى أعلى مما كانت عليه قبل عام ١٩٦٥ هو الهدف الأول الحيوى والضرورى فى مرحلة التقدم والبناء » .

علينا أن نضع القرية فى وضعها الصحيح لتؤكد دورها فى عملية الانتاج والمشاركة فى انجاز الخطة القومية والمساهمة فى التنمية الاقتصادية والاجتماعية والعمرانية « لا بد أن تلقى التنمية الاجتماعية نصيبها الحق فى استراتيجيتنا الحضارية الشاملة أن هذه الاستراتيجية الحضارية الشاملة لا يمكن أن تكون تنمية اقتصادية خاصة بل لا بد أن تكون اجتماعية فى نفس الوقت « ولا شك أن وصول الكهرباء الى القرية المصرية سيرفع مستواها وبطور انتاجها كما أن وصول القوى المحركة الى كل مكان فى مصر هو شرارة الثورة القادرة على تحريك

طاقات [illegible] البشرى اقتصاديا واجتماعيا الى التقدم الذى يتطلع اليه النضال الوطني . وقد أكد السيد/ الرئيس أنور السادات فى ورقة أكتوبر على اهمية خطة كهربة الريف وذلك فى اطار المشروع الشامل لرسم خريطة جديدة لمصر .

والواقع أن الطريق الذى يمكن أن نسلكه لمعالجة مشاكل الريف الاقتصادية والاجتماعية يرتبط ارتباطا وثيقا بتخطيط مشروعات كهربة الريف بما يحقق استخدام الكهرباء بنجاح فى الأغراض الآتية :

- انارة القرى وبيوت الفلاحين ومد وحدات الخدمات بالقرية بالتيار الكهربائي .
- استبدال محركات الديزل العاملة فى قطاعات الرى وحليج الاقطان وما شابه ذلك بمحركات كهربائية .
- تشغيل آلات الزراعة بالكهرباء مثل آلات الحصاد والكبس والتعبئة والطحن والعصر .
- تشجيع الحاصلات الزراعية سواء بالتجفيف أو التبريد أو خلافه .
- فتح مجالات كثيرة للتصنيع فى الريف خاصة فى الصناعات الصغيرة والحرفية والبيئية وكهربة الآلات صناعة الألبان .
- توصيل الخدمات الاعلامية المسموعة والمرئية الى أعماق الريف .
- خلق جوانب ايجابية فى مشروع تنظيم الأسرة نتيجة التوعية الاعلامية وشغل أوقات الفراغ بالخروج الى النوادى والمنتديات العامة .

مما لا شك فيه أن دخول الكهرباء فى الريف المصرى على الأساس السابق سيصحبه ترغيب الفلاحين فى عدم الهجرة من القرية الى المدينة وتشجيع لأهل الحضر على الارتباط بقراهم والتردد عليها .

وقد ألقى السيد/ المهندس عبد الفتاح عبد الله نقيب المهندسين ووزير الدولة لشئون رئاسة الجمهورية كلمة منها :

أن الكهرباء هى القلب النابض للتقدم الحضارى والاقتصادى والاجتماعى وأحد العمد الرئيسية لرفع مستوى المعيشة فى المدن والريف على حد سواء . وأصبح ما يخص الفرد من الكهرباء المنتجة فى الدولة أحد المقاييس الرئيسية لمقدار تقدمها .

ومن المعروف أن ريفنا الذى ننعم جميعا بخيراته قد حرم طويلا من نعمة الكهرباء أحد الأسباب الرئيسية للتقدم والازدهار .

وقد آن الأوان لنعوضه عما فاته من سنوات الحرمان والتخلف ولتحقيق له مزيدا من الرفاهية أملاً فى الوصول به الى المستوى الحضارى المرتقب .

لقد أصبح دخول الكهرباء فى ريفنا حتى يمكن اللحاق بالتطور التكنولوجى فى الميكنة الزراعية والتوسع الرأسى والأفقى دعما للتنمية الزراعية .

هذا بجانب التأثير على التوسع فى استخدام مرافق التعليم والثقافة ووسائل نشر الوعى الاعلامى الصوتى والمرئى وما لذلك من أثر مباشر على المستوى الاجتماعى للفرد .

ومن الكلمة التى ألقاها السيد / الدكتور مهندس أحمد محرم رئيس جمعية المهندسين المصرية :

« كنا نتطلع فى هذا الوطن الى تعميم مياه الشرب فى المدن ، وما أن تحقق ذلك حتى تطلعنا الى تعميم مياه الشرب فى القرى ، وقد تم والحمد لله أو هو على وشك التمام . ثم تطلعنا الى تعميم الكهرباء فى المدن ، وما أن تحقق ذلك أيضا حتى راودتنا الآمال فى تعميم الكهرباء فى الريف المصرى . كان أملا ، ثم تحول الأمل الى فكرة ، ثم أخذت الفكرة بجدية بعد نضوجها لترى طريقها الى النور عندما دعى اليها عام ١٩٦٨ أى منذ ست سنوات ، السيد محافظ المنوفية ، المهندس أحمد سلطان ، أخذ يدعو اليها فى كل المجالس وفى كل المؤسسات ، ويذلل كل العقبات وكل المعوقات ، فتحولت الفكرة الى مشروع قائم ، تتحمل الآن وزارة الكهرباء وهيئة كهربة الريف مسئولية تنفيذه ، وتحقيق الهدف من انشائه .

وفى وقت كان تقدم الدول يقاس بما يناله كل مواطن من أطوال الطريق ، ثم أصبح هذا التقدم يقاس بما يناله المواطن من قسط الكهرباء . فالى مزيد من الأمل ، والى مزيد من التطلعات ، والى مزيد من انتاج الكهرباء ، حتى تصل الى مزيد من التقدم المنشود . فليتحول الوقود بأنواعه الفحم والغاز والبترول الى كهرباء ويتحول سقوط المياه الى كهرباء ، والطاقات الذرية والنووية أيضا الى كهرباء هذا ما فعله من سبقونا الى التقدم .

ثم ألقى السيد / المهندس محمد صقر أمين عام اتحاد المهندسين العرب كلمة جاء فيها :

« بدأ اهتمام المهندسين العرب بموضوع تنمية الطاقة الكهربائية فى البلاد العربية وتنميط الضغوط والمعدات منذ المؤتمر الهندسى العربى الأول الذى عقد فى مدينة الاسكندرية عام ١٩٤٥ ولم يخل مؤتمر من المؤتمرات الهندسية العربية الاثنى عشر التى عقدت حتى عام ١٩٧٢ من الاشارة الى أهمية تنمية الطاقة الكهربائية فى البلاد العربية ووضع منهاج لربط الشبكات الكهربائية فى البلاد العربية المتجاورة » .

وقد اختتم المؤتمر أعماله بالتوصيات الآتية :

١ ـ حيث أن مشروعات كهربة الريف من المشروعات الاستراتيجية اللازمة للحضارة الشاملة التى لا تحتمل التأجيل يؤكد المؤتمر على ضرورة اتاحة الطاقة الكهربائية فى الريف لاستخدامها فى

الاغراض الزراعية والصناعات البيئية والحرفية الى جانب الخدمات والمرافق العامة .

٢ ـ لتدعيم فوائد ونتائج استخدام الطاقة الكهربائية فى الريف ضمانا لسرعة تزايد معدلات التنمية الاجتماعية والاقتصادية ، ينبغى توفير شبكات الطرق والاتصالات لربط القرى بالمدن .

٣ ـ تشجيع قطاع الصناعة فى الدول العربية بتخصيص جزء من استثماراته لانشاء المصانع فى المناطق الريفية بهدف تحسين اقتصاديات مشروعات الكهرباء .

٤ ـ التنسيق بين الدول العربية لتحقيق التكامل الصناعى فيما بينها بشأن انتاج وتطوير خطة تصنيع المهمات الكهربائية والتوسع فيها بغرض مقابلة متطلبات تنفيذ مشروعات كهربة الريف والاستغناء تدريجيا عن استيراد هذه المهمات من الدول الأجنبية .

وعلى سبيل المثال فان الصناعات الجديدة المطلوبة هى انشاء صناعات العازلات الزجاجية والخزفية ، والقواطع والمفاتيح الكهربائية ، والمصهرات وملحقات الخطوط الهوائية ، والآلات الزراعية الكهربائية ، كما أن الصناعات القائمة المطلوب التوسع فيها هى مثلا المصابيح الكهربائية والكابلات والاسلاك ، والمحولات الكهربائية ، ومضخات الرى وماكينات تصنيع وحفظ المنتجات الزراعية مثل الثلاجات وفرازات الألبان والعصير والتعليب .

٥ ـ توحيد المواصفات الفنية والقياسية للمهمات المستعملة فى مشروعات كهربة الريف بين الدول العربية للحصول على أكبر فائدة ممكنة من التكامل الصناعى .

٦ ـ تنميط نظم التركيب والانشاء لمشروعات كهربة الريف ووضع المواصفات الفنية الموجودة لها بهدف تطوير أساليب التركيب الحالية الى الأساليب الحديثة وتدعيمها بالمعدات الآلية التى ترفع معدلات مستويات الأداء وبالتالى تحقق خفضا فى التكاليف وتحسينا فى الأداء .

٧ ـ التأكيد على تطبيق الأساليب العلمية الحديثة وذلك بقيام الجامعات بالدراسات والبحوث التطبيقية لكى تشمل كافة المجالات التى تتصل بمشروعات كهربة الريف وميكنة الآلات الزراعية وتطويرها بما يتيح سهولة وكفاءة استعمال الطاقة الكهربائية لتشغيلها وذلك بالتعاون الوثيق المثمر بين الجامعات ومؤسسات وهيئات الدول المعنية .

٨ ـ قيام الجامعات والمعاهد العليا بتطوير المقررات التعليمية لادخال التخصصات التى تتعلق بتنمية القرى والمناطق الريفية اقتصاديا واجتماعيا وبكهربة الريف واعداد برامج دراسات عليا لرفع كفاية الخريجين فى هذه المجالات .

٩ ـ التأكيد على عقد مؤتمرات دورية لكهربة الريف تتضمن اجراء دراسات ميدانية فى مواقع التنفيذ بالدول العربية ، ويشترك فيها الهيئات العلمية المختصة وخبراء الكهرباء والصناعة والزراعة والرى والاسكان والتخطيط وممثلى الفلاحين أصحاب المصلحة الحقيقية فى كهربة الريف .

١٠ حث الهيئات الهندسية بالدول العربية الأخرى التى لم تشترك فى هذا المؤتمر لكى يكون تبادل الآراء أكثر شمولا لحضور المؤتمرات القادمة وعلى اتحاد المهندسين العرب أن يتولى القيام بهذه المهمة .

١١ ـ التأكيد على وسائل الاعلام المختلفة للقيام بدورها البناء فى النهوض بالمستوى الثقافى للقرية باعداد برامج توعية لاستخدامات الكهرباء فى الريف وحث الجهود الذاتية للأهالى على المساهمة فى مشروعات كهربة الريف وحسن استغلالها والمحافة عليها .

١٢ ـ تخطيط وتطوير واجراء دورات التدريب للقطاع الهندسى بكافة مستوياته للحصول على القوى العاملة اللازمة لضمان القيام بالتصميم والتخطيط والتنفيذ والتركيب والتشغيل والصيانة المطلوبة .

١٣ ـ الاستفادة من الخبرات والبحوث الأجنبية لتطبيق ما يصلح منها فى البلاد العربية بعد تطويرها بما يلائم طبيعة هذه البلاد .

١٤ ـ التوسع فى تبادل الخبرات والآراء والفنيين مع الدول الافريقية بهدف زيادة توطيد العلاقات بينها وبين الدول العربية ، وتقديم المساعدات الممكنة فى هذه المجالات .

١٥ ـ انشاء مركز الكترونى لخزن وتحليل المعلومات المتعلقة باستثمار وتطوير المشاريع الكهربائية بعد التنفيذ .

١٦ ـ الاسراع بتأسيس بنك أو صندوق عربى لمشروعات الكهرباء شاملة كهربة الريف والصناعات الكهربائية فى جميع البلاد العربية .

١٧ ضرورة الاستعانة ببيوت الخبرة الاستثمارية عربية مشتركة للقيام بأعمال التصميم الفنى للمشروعات والاشراف على تنفيذها .

١٨ ـ التأكيد على أهمية التعاون مع منظمات الجامعة العربية .

١٩ ـ ضرورة الاستعانة بشركات التنفيذ العربية القائمة وتشجيع قيام شركات عربية مشتركة لتنفيذ هذه المشروعات الكهربائية .

٢٠ ـ قبول دعوة وفد العراق بالمؤتمر لعقد المؤتمر العربى الثانى لكهربة الريف ببغداد خلال شهر ابريل ١٩٧٥ .

٢١ ـ تشكيل مجلس دائم من الهيئات المعنية فى مختلف البلدان العربية يجتمع بشكل دورى لمتابعة تنفيذ هذه التوصيات .

عبور النقل النهري عصر التخلف
إلى.. عصر السرعة والاقتصاد

العبور الأول تم فى العاشر من رمضان بنجاح فاق كل تصور ، وذلك لأن الاعداد له تم بطريقة علمية ودرست كل تفاصيله الدقيقة بعناية ، وفى سرية كاملة ، فى ظل الايمان بالله وبقدرات شعبنا الخلاق .

والعبور الثانى هو ما ينطبق عليه وصف الرئيس بأنه سيكون « العبور الى الرخاء » وهذا ما تم فعلا بتحويل ترعة النوبارية الى ترعة ملاحية من الدرجة الأولى .. ويعتبر هذا المشروع أضخم مشروعات الثورة فى مجال النقل النهرى حتى الآن .. وقد تم الاعداد له وتنفيذه أثناء الاعداد لمعركة التحرير والنصر .. وقد بلغت تكاليف هذا المشروع الوطنى الكبير ٢٥ مليون جنيه فى قطاع النقل فقط وبافتتاح هذا العمل العظيم أصبحت الوحدات النهرية تقطع المسافة بين القاهرة والاسكندرية فى ثلاثة أيام فقط بعد أن كانت تقطعها فى عشرة أيام .

وقد أناب الرئيس محمد أنور السادات الدكتور عبد العزيز حجازى النائب الأول لرئيس الوزراء فى افتتاح مشروع ترعة النوبارية الى ترعة ملاحية من الدرجة الأولى ، وصحب النائب الاول لرئيس الوزراء ، وزراء النقل والمواصلات ، الصناعة ، الرى ، التجارة الخارجية ، الزراعة ، الدولة لشئون السودان ، الحكم المحلى ، التأمينات الاجتماعية ، الدولة لشئون مجلس الوزراء ، الدولة لشئون مجلس الشعب ، الأزهر والشئون الاجتماعية ، السيد محافظ الاسكندرية وأمين الاتحاد الاشتراكى المساعد وقد كان فى استقبالهم المهندس جعفر محمد عبد الله رئيس مؤسسة النقل النهرى عند موقع هويس الميناء حيث تتصل الوصلة الملاحية لترعة النوبارية بالبحر الأبيض المتوسط عند ميناء الاسكندرية .

وفى الاحتفال الذى أقيم بهذه المناسبة ألقى الدكتور عبد العزيز حجازى وبعض الوزراء كلمات أشادوا فيها بأهمية المشروع من الناحية الاقتصادية والسياسية والاجتماعية كما أثنوا على جهود الرجال الذين قاموا بتنفيذه .

وقد تحدث المهندس جعفر محمد عبد الله رئيس مؤسسة النقل النهرى عن اقتصاديات المشروع والخبرات المصرية التى تعاونت فى تنفيذه فقال « الحمد الله الذى وفقنا لانجاز عمل ضخم من أعمال الثورة المجيدة ، فالمشروع الذى نحتفل بافتتاحه اليوم يعتبر عملا ثوريا بناء فى مجال النقل النهرى ، ونرجو الله أن يوفقنا لحسن ادارته واستغلاله ليدعم اقتصادنا القومى » .

فالنقل النهرى لا يزال أرخص وسائل النقل ، كما يمتاز بكفائه لنقل البضائع والمواد ذات الأوذان أو الأحجام التى يصعب نقلها بوسائل النقل الأخرى ولذا كان التفكير فى نقل المليون ونصف المليون طن من الفحم الحجرى من الاسكندرية والحجر الجيرى من بنى خالد الى مجمع الحديد والصلب بحلوان عن طريق النقل النهرى أمرا طبيعيا ، وفى نفس الوقت كان ذلك مستحيلا عن طريق ترعة المحمودية وكان لا بد من اعداد المجرى الملاحى المناسب .

وقد وافق تنفيذ مشروع مجمع الحديد والصلب تنفيذ مشروعات التوسع الزراعى فى غرب الدلتا التى تتطلب عمل توسعات فى ترعة النوبارية لتفى باحتياجات الرى والتى كان المفروض أن تنتهى عند الكيلو ٩٥ واستقر رأى الخبراء على أن تستغل ترعة النوبارية بتحويلها الى مجرى ملاحى من الدرجة الأولى وتمتد بوصلة ملاحية حتى ميناء الاسكندرية عبر بحيرة مريوط ، ثم تخترق مدينة الاسكندرية لتتصل بالبحر الأبيض المتوسط . أن هذا المشروع يعتبر من النماذج الناجحة للتعاون والتنسيق بين الوزارات المختلفة وهى الزراعة والرى والصناعة والنقل وتحويل ترعة النوبارية الى ترعة ملاحية تطلب ازالة ١٤ كوبريا كانت عليها واقامة نفس العدد من الكبارى العلوية وازالة ثلاث قناطر ، وانشاء ٤ أهوسة جديدة ، عند مدخل الترعة من الرياح البحيرى وعند كفر بولين وعند الكيلو ٢٨ر٥٠٠ وعند الكيلو ٦٢ وكيلو ١٠٠ عند نهاية الترعة .

وهذا الهويس ينقل وحدات النقل من منسوب ٣ر٥ متر فى ترعة النوبارية الى منسوب ناقص ٢ر٥ فى بحيرة مريوط ، من هذا الهويس تبدأ الوصلة الملاحية بشق القناة من الأرض الصخرية حتى أول البحيرة ثم شق القناة من البحيرة حتى شاطئها المجاور لها . واذا تصورنا هذه المنطقة بما كانت عليه من مبان ثم كيف أزيلت ونحت الصخر بأحدث الآلات دون استخدام المتفجرات لدواعى الأمن ، ندرك الجهد الجبار الذى بذله العاملون فى انجاز هذا العمل الوطنى الكبير ،لقد أقيم على هذه الوصلة الملاحية كوبرى الطريق الصحراوى وصحارة مصرف العموم وتعتبر فى نظر خبراء الرى أضخم منشأة من نوعها فى الشرق الأوسط ، ثم كوبرى خط سكة حديد مصر/ مرسى مطروح وكوبرى المكس وعند تلاقى الوصلة الملاحية بالبحر الأبيض المتوسط

أنشىء هويسان ومجموعة كبارى متصلة بهما وتعتبر هذه المنطقة فى مجموعها أضخم منشآت المشروع .

يمتد الخط الملاحى بعد ترعة النوبارية الى القاهرة عن طريق الرياح البحيرى ويجرى العمل فى انشاء هويسين جديدين أحدهما عند الخطاطبة وقد أوشك على الانتهاء والثانى عند نهاية الرياح فى القناطر الخيرية .

وقد بلغت تكاليف المشروع فيما يختص بالنقل ٢٥ مليونا من الجنيهات بخلاف الأعمال الخاصة بالتوسعات الزراعية ، وبتنفيذ هذا المشروع أصبحت وحدات النقل النهرى تقطع المسافة بين القاهرة والاسكندرية فى ثلاثة أيام بدلا من ١٠ أيام عن طريق ترعة المحمودية وكفاءة الهويس على ترعة المحمودية وسترفع كفاءة الوحدات العاملة بين القاهرة والاسكندرية أربعة أضعاف ، كما أن طاقة النوبارية بمرور وحدات النقل تعادل ٣٠ ضعفا لطاقة ترعة المحمودية ، وسوف يسمح بزيادة كفاءة الوحدات مستقبلا بعد تحويل الكبارى المتحركة على الرياح البحيرية الى كبارى علوية وقد جهزت ترعة النوبارية بامكانيات الملاحة النهرية وسوف ترتفع بذلك كفاءة النقل بعد تنفيذ الملاحة الليلية .

وبعد حفل الافتتاح قام الدكتور عبد العزيز حجازى ومعه الوزراء بازاحة الستار عن اللوحة التذكارية للمشروع ثم استقلوا باخرة نيلية لتفقد بعض منشآت المشروع الممتدة على طول القناة الملاحية من ميناء الاسكندرية حتى بحيرة مريوط ، وشاهد النائب الأول لرئيس الوزراء على الطبيعة عملية الملاحة وحركة وحدات النقل عبر القناة الجديدة ..

العلاقات العامة

مصر صناعة بترولية نامية

تقع مناطق البترول فى ج.م.ع . فى ست مناطق هى :

١ ـ **خليج السويس**
٢ ـ **البحر الأحمر**
٣ ـ **الصحراء الغربية**
٤ ـ **دلتا النيل**
٥ ـ **حوض النيل**
٦ ـ **شمال سيناء**

ومنذ بداية القرن الحالى الى الآن تم اكتشاف ٣١ حقلا لزيت البترول الخام والغاز الطبيعى وقد عقدت مجموعة من العقود البترولية أخيرا . والجدير بالذكر أنه منذ انشاء وزارة البترول فى أواخر مارس ١٩٧٣ وحتى الآن تم ابرام ٢٤ اتفاقية للبحث عن البترول وانتاجه فى مصر وبعض هذه الاتفاقيات تحت اجراءات الاستقرار .

وتتجه مؤسسة البترول فى الوقت الحالى الى عقد اتفاقياتها البترولية مع شركات البترول الأجنبية على أساس عقود « اقتسام الانتاج » . وهذا النظام يمكن ايجازه فى الآتى :

ما هى عقود اقتسام الانتاج :

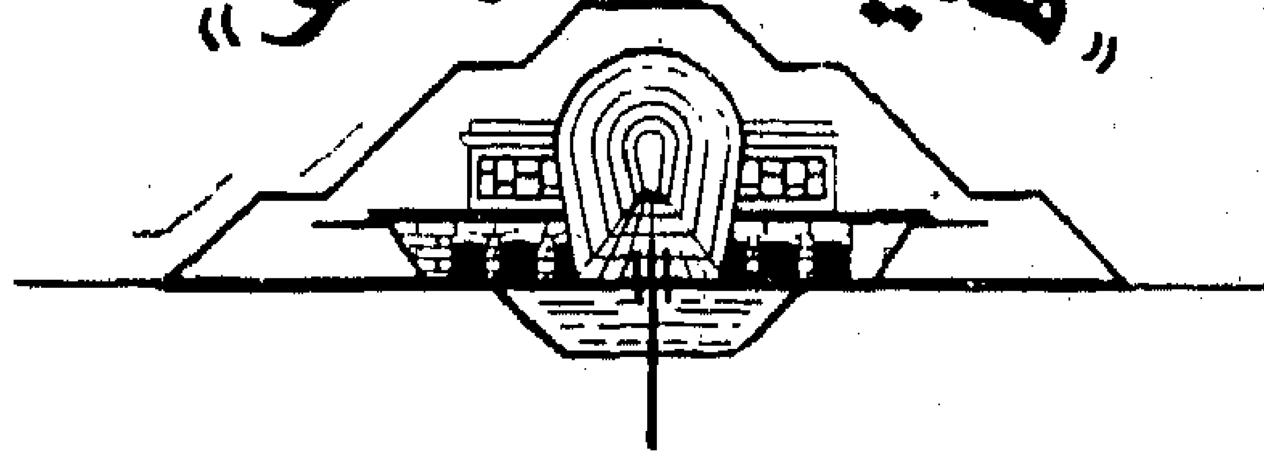
تصل مدة البحث فى هذا النوع من العقود الى ثمان سنوات وتتراوح مدة التنمية (الاستغلال) بين ٢٠ و ٢٥ سنة ، وتلتزم الشركة الأجنبية بالانفاق خلال فترة البحث ، وتسترد الشركة المصروفات التى انفقتها عينا بكميات من الزيت الخام بنسبة مئوية معينة من الانتاج (٤٠٪ مثلا) ويوزع باقى الانتاج بين المؤسسة والشركة .

وعندما يتحقق اكتشاف تجارى يتم تكوين شركة بين مؤسسة البترول والشركة الأجنبية وتتولى الشركة تنمية المنطقة واستغلالها .

والأمل كبير فى أن توفق الشركات العاملة الى مزيد من الاكتشافات البترولية ، بحيث يمكن بلوغ أهداف الخطة البترولية التى ترمى الى انتاج ٤٥ مليون طن من الزيت الخام وعشرة ملايين من الأطنان من غاز البترول السائل فى عام ١٩٨٣ .

شركة السد العالي للأعمال المدنية

« هيداسيفكو »



أخصائيون في :

- إقامة السدود والقناطر
- أعمال التفجير
- أعمال الترع والمصارف
- الأعمال الإنشائية

- حفر وإنشاء الأنفاق
- محطات الري والصرف
- شبكات الصرف المغطى والمكشوف
- إختبار التربة والحقن

إحدى شركات المؤسسة المصرية العامة لمشروعات الري والصرف

القاهرة : ١٥ شارع الدكتور طه حسين بالزمالك « ولكوكس سابقاً »

تليفون : ٨١٢٨٤٩ - ٨١٢٨٦٠

الأعمال التي قامت وتقوم الشركة بتنفيذها

- مشروع حفر نفق وادي الريان بطول ٨ كيلومتر والأعمال المدنية الملحقة به « تم تنفيذه »
- مشروع إنقاذ معابد فيلة بأسوان
- تشغيل وصيانة طلمبات التخفيف بمجمع الحديد والصلب بحلوان « تم تنفيذه »
- عملية تخفيض منسوب المياه الجوفية بمجمع الحديد والصلب بحلوان « تم تنفيذه »
- الأعمال الترابية والصناعية لتعميق المصارف بكوم أمبو وتنفيذ مشروعات الري بها.
- إنشاء الأنفاق .
- شبكات الصرف المغطى ببني صالح لمساحة ٢٤٠٠٠ فدان
- شبكات الصرف المغطى بمنطقة سيل ٣ ، ٤ ، ٥ لمساحة ٩٢٠٠٠ فدان .
- شبكات الصرف المغطى بنجع حمادي لمساحة ٩٠٠٠ فدان
- عملية نقل محطة طلمبات الجلاوية إلى محطة بني صالح
- إنشاء محطة طلمبات بني صالح .
- تغذية مطار أبو سمبل بمياه الشرب
- عمل الدراسات والإختبارات اللازمة لمجرى نهر النيل لدراسة النحر من أسوان إلى الدلتا.
- عمليات الصرف المكشوف .
- عمليات حقن الكباري والقناطر بوردان والسنايطة ونجع حمادي .
- عملية إنشاء مصرف البسيوني والأعمال الصناعية عليه بأسيوط .
- الأعمال الترابية والصناعية لفروع الري والصرف لمنطقة فارسكور وبلبيس وإيتاي البارود
- محطة طلمبات القلعة الجديدة بالإسكندرية
- عملية إنشاء محطة طلمبات رقم ٤ على النوبارية
- عملية إنشاء دليل المص والطرد لمحطة طلمبات حنيبة والمنشأة الخاصة بالمحطة .
- الأعمال الترابية والصناعية للترعة الشرقية ومصرف منور السيل البحري .

والشركة تقوم بتقديم خبراتها في كل مكان في البلاد العربية وتقوم حالياً بتنفيذ المشروعات التالية بالجمهورية العربية الليبية

★ عملية وادي كعام .. وتشمل :

- عملية سد وادي تربت
- عملية مصب وادي كعام
- عملية وادي داكار
- حقن ستارة سد وادي كعام
- حفر الآبار الإختبارية والإنتاجية

★ عملية محطة إزالة ملوحة المياة بزليطن

★ عملية سدود وادي جارف

والشركة تنفرد عن مثيلاتها في أعمال تثبيت التربة بطريقة الحقن ، وأعمال حفر الأنفاق وأعمال نقل الرمال بالتجريف الهيدروليكي ، إلى جانب إنشاء السدود

يقدمون ...

أكبر إنتاج ..

أكبر تصدير ..



المؤسسة المصرية العامة للغزل والنسيج

وال ٢٨ شركة التابعة لها

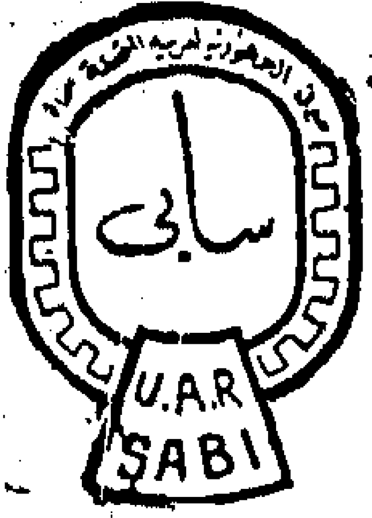
وبسواعد ٢٥٠ ألف من العاملين
اقتحمت بإنتاج شركاتها المتفوقة
معظم الأسواق العالمية محققة للبلاد
حصيلة ضخمة من العملات الأجنبية



الإنتاج السنوي
٤٠٨ مليون جنيه

الصادرات
٧٢ مليون جنيه

الأسواق الخارجية
٨٤ دولة في العالم



الشركة المصرية للصناعات الميكانيكية الدقيقة

« سابى »

إحدى شركات المؤسسة المصرية العامة للصناعات الهندسية والكهربائية والالكترونية

تقدم بكل فخر

صناعات عربية ومواصفات عالمية.. تشق طريقها الى كل الأسواق الداخلية والخارجية وتتمتع بسمعة رفيعة.

إن الخبرة والتجربة التى وصلت اليها شركة « سابى » فى انتاج صنابير المياه والمحابس وجميع أدوات الحمام، كفيلة بضمان جودة استعمالها لمدة طويلة مع إحكام القفل والفتح، دون أن تتعرض أجزاؤها الداخلية للإستهلاك، وذلك لأنها صممت بطريقة علمية خاصة باستعمال العامود الذى لا يرتفع.

NONRISING SPINDLE

- الى جانب إنتاجها المتطور من :
- اللوازم المعمارية من الكوالين والأقفال
- الشناكل والمفصلات والسباليونات
- أنواع الصنفرة المختلفة
- سوست ملابس جميع المقاسات
- مبارد حدادى
- سدادات معدنية
- بوجيهات ماركة « لوديج » العالمية

معرض الشركة

القاهرة : ٢٦ شارع شريف
« عمارة الاليمبيا » ت ٥١٥٢٨

فرع ليبيا

السيد/ عبد المحسن عاكف
صالحين البلوشى
١٠ شارع الجمهورية
طرابلس

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تليفون : ٨٦٤٤٩١ - ٨٦٤٧٢٧ تلغرافيا : سابيجيلت
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التصنيع والانتاج

جمعية المهندسين الكهربائيين
والالكترونيين
جمعية الهندسة الادارية
جمعية المهندسين الميكانيكيين

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be considered to take into account the effect of the earth wires, non-transposition and the effect of the earth return on the positive phase sequence impedance of the line. A full scheme will be introduced together with the settings, which may be considered as a preliminary study for using static relays for the protection of this line instead of the phase differential protection where were already employed.

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The most important merit of the new technique is the simplicity and easiness by which the slope of the straight lines characteristics shown in fig. (3) may be adjusted. This is done by changing the limit $\propto$ or β as indicated from equations 8 or 9. This is verified by simply shanging the value of the capacitor C in the quasi-stable network shown in fig. (13). In the former comparators (13), this procedure necessitates the variation of the constants K_1, K_2, K_3, and K_4. This comparator permits also the production of complex characteristics shapes by varying the signal arrays derived from the power system. The coordination problems inherent with the use of 2-input comparators connected in combination (13) is avoided.

V. Relay adjustment

Equation 2, 3, 4, define exactly the relation between the limits of comparison and the delay and comparison periods of each pair of signals. Consequently, if the positive phase sequence impedance of the transmission line is known, the angle Θ_1 in fig. (4) can be found together with the point B, since the resistive reach of the relay bears a certain ratio to the magnitude of the relay coverage impedance taken safely to be equal to 40%.

Hence point C can be found.

The limits of comparison of each pair of signals can be found then the delay and comparison periods can be found together with the point B, since the resistive reach of the relay bears a certain ratio to the magnitude of the relay coverage impedance taken safely to be equal to 40%. Hence point C can be found.

The limits of comparison of each pair of signals can be found then the delay and comparison periods can be found using quations 2, 3, 4 and realized after choosing one delay period as zero to simplify the solution. The delay and comparison periods can be adjusted in the quasi-stable stages.

VI. Conclusion

This paper illustrates the design features and the performance of a static relay based on the block average technique. The characteristic ofthis relay is of the quadrilateral type. The viability of the quadrilateral characteristic for impedance schemes is evident, since it was proved to havo the appropriate coverage for all possible fault arc resistances encountered in power circuits. This can be fulfilled in the relaying circuitry by the value of the replica impedance K_4 in the signal S_2. For heavy loading conditions, it saves the use of the blinders used with the conventional mho characteristic relays to avoid load incroachments (9).

In addition, the immunity of new comparators to power swings occuring in power circuits is achieved for a large range of swing angle δ (22). These factors create new dimensions for research work for impedance protection in this trend, and make it the target for the furture schemes especially those which will use the "ON Line digital computer schemes" for E.H.V. over head transmision lines. It must be mentioned that, the false tripping due to stray voltages from neighbouring circuits and the switching or fault d.c. component in those comparators based on he block average technique are more or less reduced to a minimum.

A full model of the new comparator is present in Cairo University, Faculty of Engineering which was built to go with the most modern theories of the fully static impedance relays.

Another paper will follow, which will illustrate the application of such relays for the protection of the 500 K.V. Aswan — Cairo double circuit, untransposed transmission line. Special precautions will

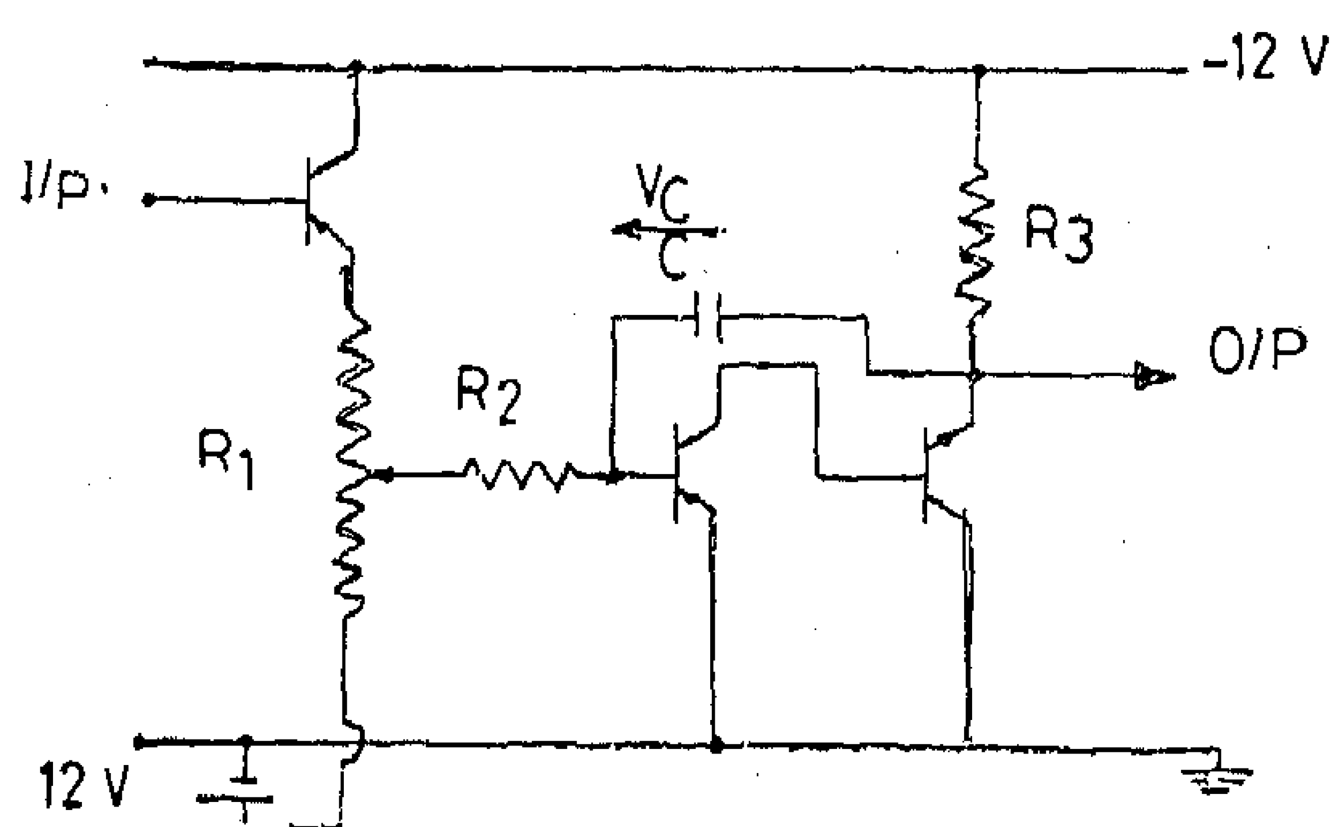


FIG (18) LINEAR INTEGRATOR CIRCUIT

decrease gradually at another rate. Hence the output waveform of the integrator is of triangular shape as shown in fig. (11).

III. 6. The level detector:

The level detector circuit is shown in fig. (19). This circuit corresponds to the balance, which will give an indication when the input voltage comming from integrator equals or is greater than the setting value of the detector, V_s in fig. (11). The output of the detector is used to operate the amplifier and reed relay and hence trip coil of circuit breaker of the protected circuit as in fig. (15). The detector is in reset when the integrator voltage is equal or less than the reset value V_r of the detector.

III. 7. The output stage :

The output stage consists simply of a transistor amplifier and a reed relay which is connected to the collector of the transistor. The reed relay contact is connected in series with the trip coil of the circuit breaker as shown in fig. (14). Due to the inductance of the reed relay, a back emf is developed between the collector and emitter of the transistor at the instant of driving the base current to that of the off state, which may cause transistor failure. To eliminate this danger a diode is connected across the relay, so that when the collector voltage rises above the supply voltage, the diode conducts and the current through the transistor falls at at a rate determined by the switching characteristics of the transistor. This is shown in fig. (15). The resistance in series with the diode is to limit the current through the diode and relay.

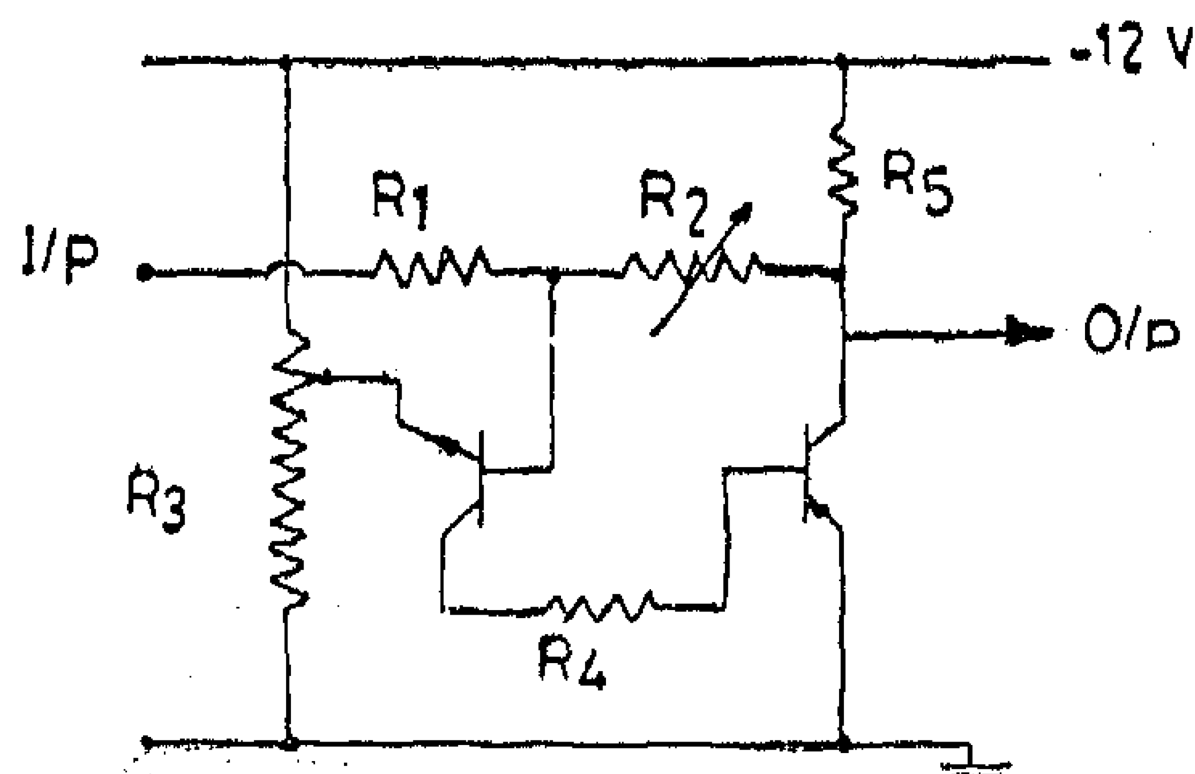


FIG (19) LEVEL DETECTOR

IV. Multi-input comparator and its privilege :

This comparator had been assembled at Faculty of Eng., Cairo University. In this comparator the steady state time response is very largely in fluenced by the set or pick up level of the level detector circuit, where minimum value of such setting is limited by the necessity to preserve dynamic accuracy. The effect of the tra nsient off set within one of the relaying signals is to cause the successive zero crossings to be advanced and retarded in relation to the steady state component. Under transient conditions the output of the comparator, which is arranged to measure twice per cycle, will alternately be increased and decreased. The level detector pick up level necessary to avoid transient errors is generally lower for generalized comparators than those for the former coincidence based block average devices for the same conditions of operation. Fig. (7). shows the theoretical and practical response of a 2 — input comparator arranged to give tripping in the range, — $60^\circ \angle S_2/S_1 \angle 40^\circ$ for a system frequency of 50 C/S.

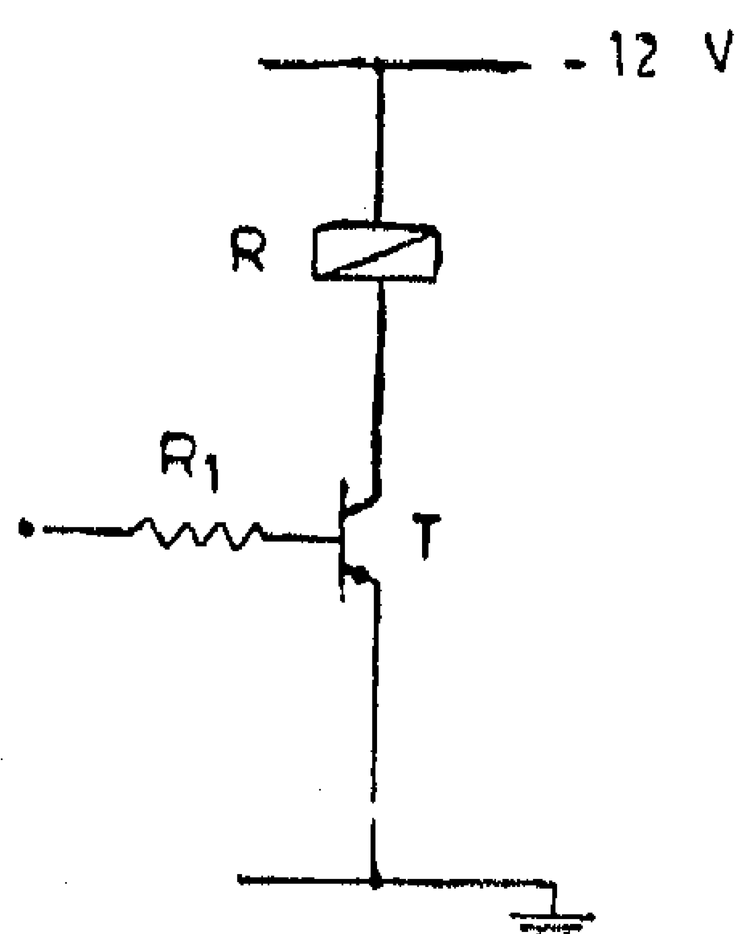


FIG (14): REED RELAY & AMPLIFIER WITHOUT PROTECTION AGAINST TRANSISTOR FAILURE DUE TO RELAY INDUCTANCE

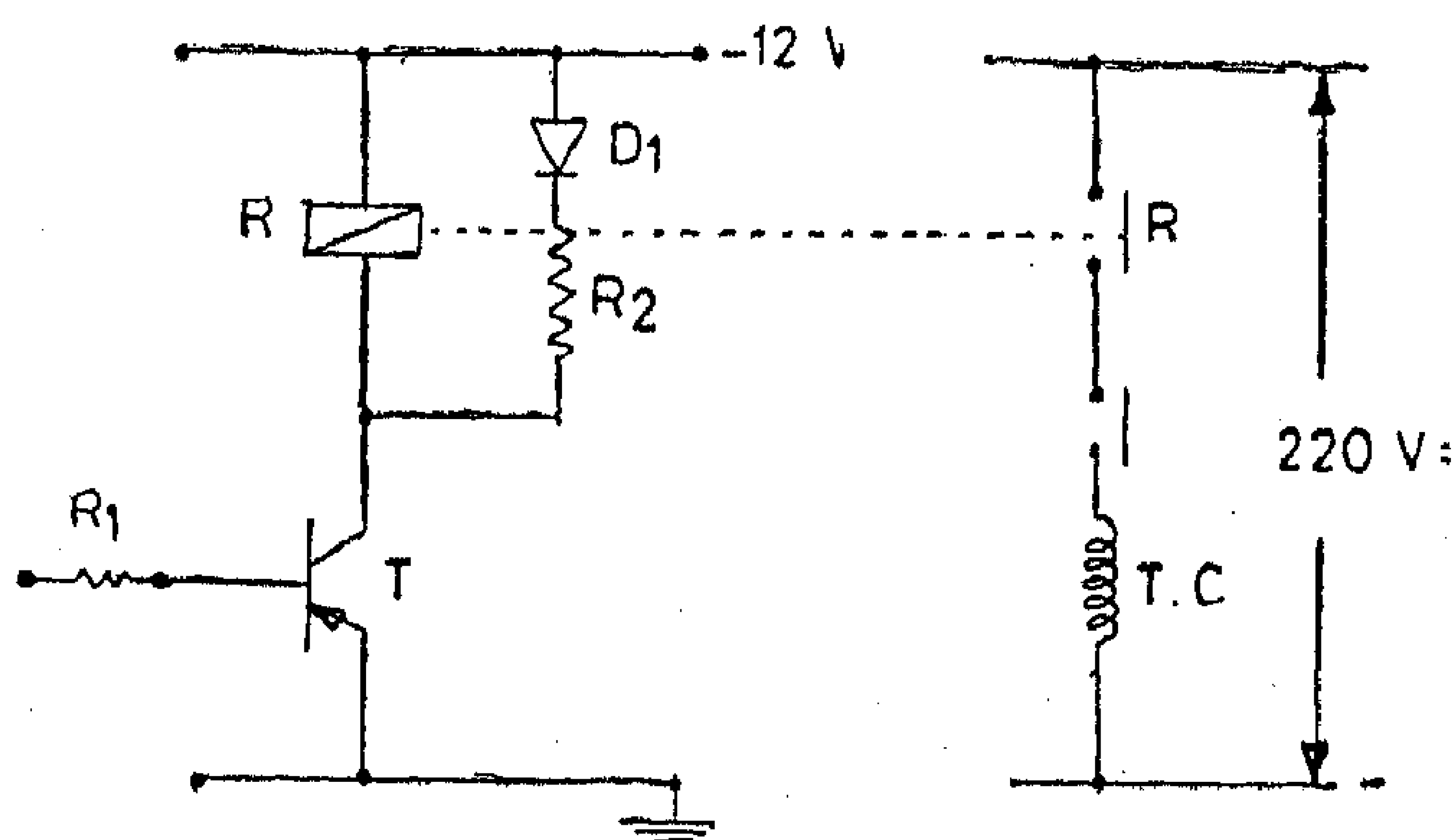


FIG (15): REED RELAY, AMPLIFIER AND TRIPPING CIRCUIT OF THE CIRCUIT BREAKER

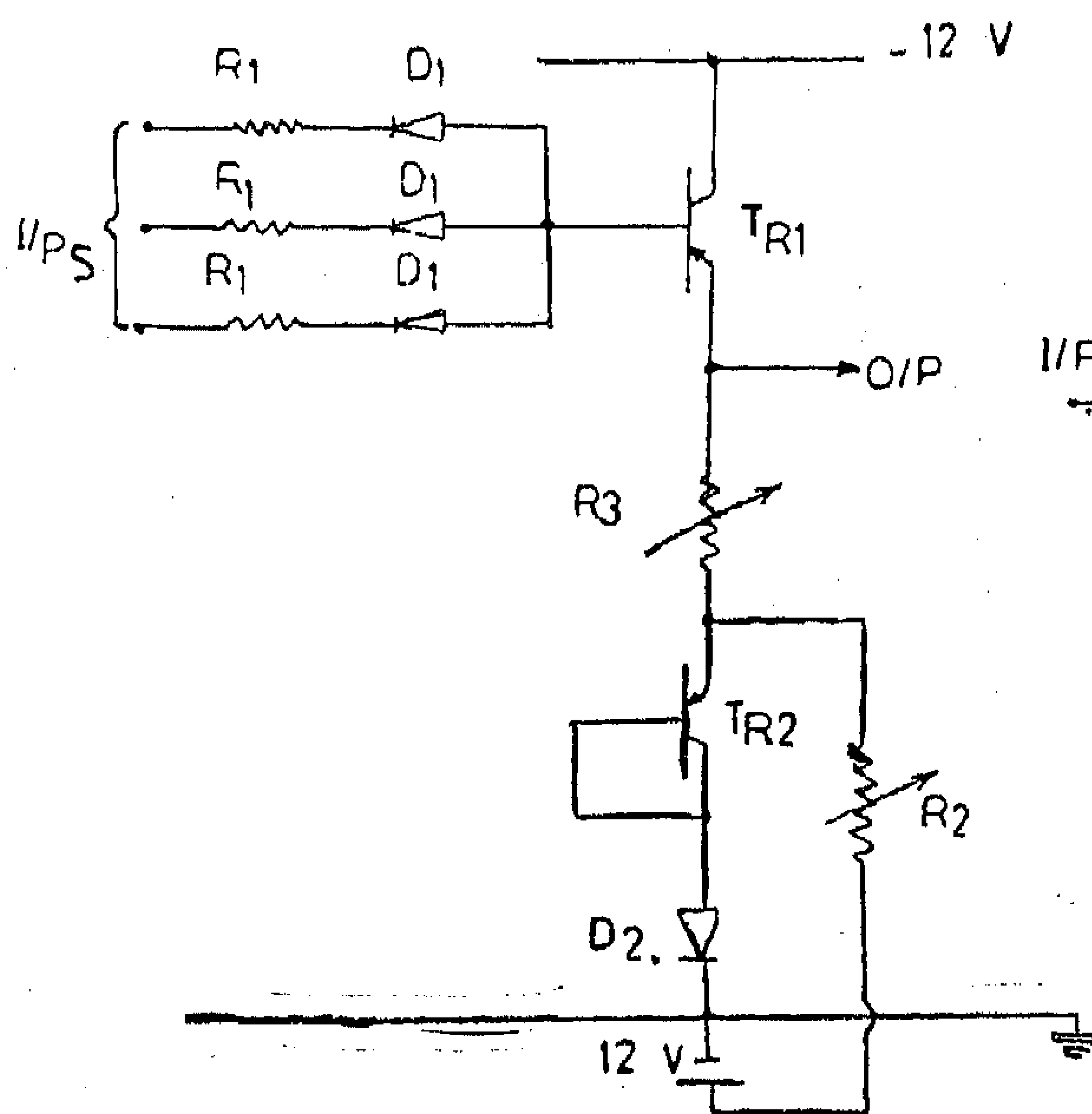


FIG (16): AND GATE

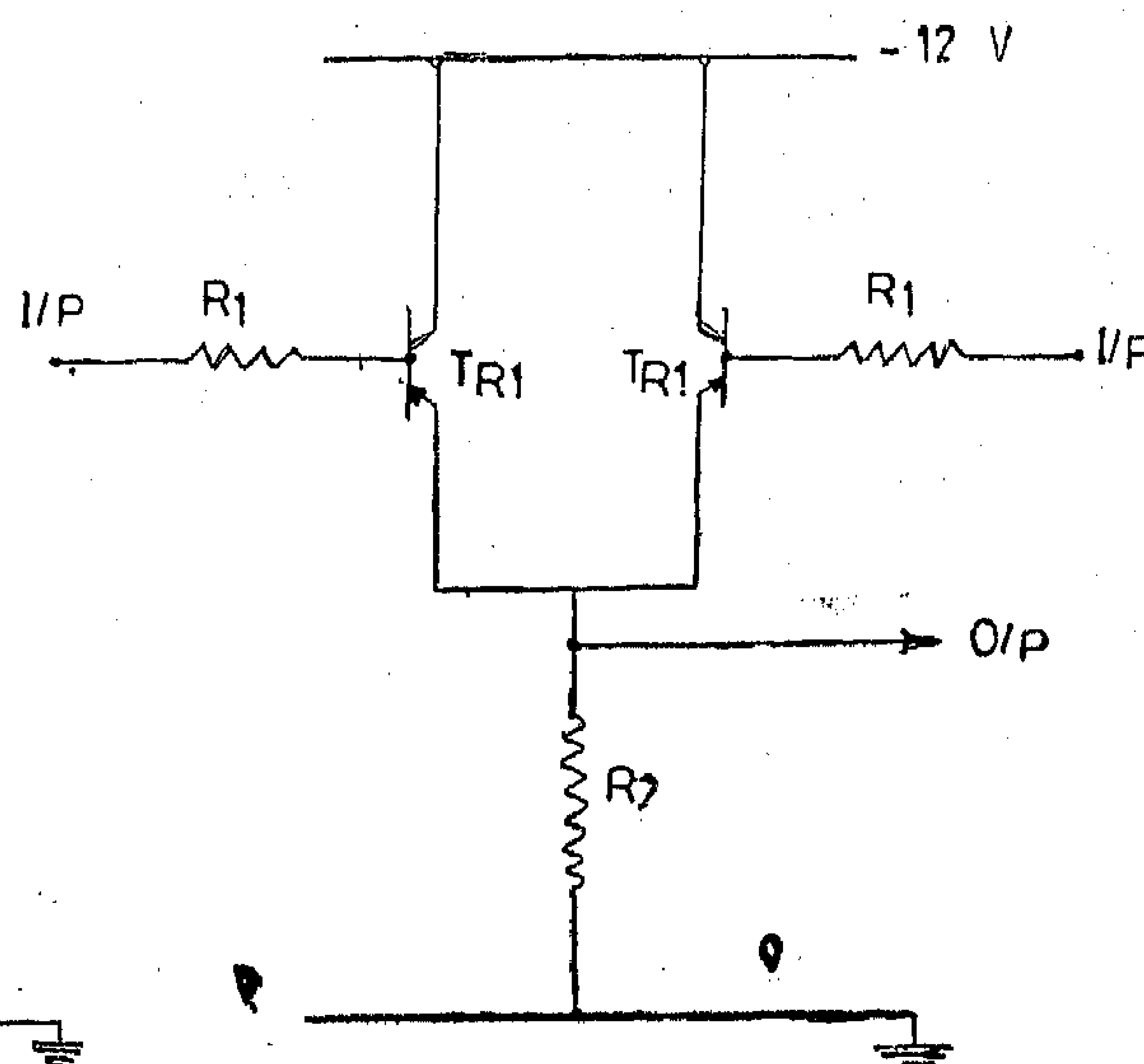


FIG (17): OR GATE

III. 4. The OR gate :

The integrator circuit is shown in fig. (17). Normally both transistors T_{r1} and T_{r2} are at cut off. I one of the inputs is $-V_{cc}$, then its corresponding transistor will be driven to saturation. Hence the output voltage, which is normally zero, will be -V

III. 5. The integrator:

The integrator circuit is shown in fig. (18). The input to the integrator is the negative output pulses of the OR gate. The output of the integrator will increase at a certain rate during the period of the negative input pulse. When the input is zero, the integrator output voltage will

the effect of the temperature drift on the input signal is eliminated. Simice the generation of comparison period pulses demands a voltage change at the input to each zero crossing detector and the comparator automatically restrains if any input signal is reduced to zero; hence the circuit instability problems are effectively removed. Transistors T_{r3} and T_{r4} are used as amplifiers for the voltage changes at collector of T_{rI}. Transistor T_{r5} is used as invertor. The diode clipping circuit at the input of the comprator ping circuit at the input of the comparator protects T from excessive voltages and offers a large range for the input voltage.

III. 2. **Quasi-stable or delay network :**

The network is shown in fig. (13). Transistors T_{rI} and T_{r3} are normally in saturation. Capacitor C is actually charged through diode D_2 and T_{r3}. When the input to the base of T_{r3} is the positive swing pulse of invertor collector voltage, then T_{rI} and T_{r3} cut off, while T goes to saturation. Capacitor C starts to discharge instantaneously and when its charge tends to zero, T_{rI} starts to conduct and rapidly goes to saturation, driving T_{r3} also to saturation. The output T_{s3} collector is a rectangular wave of duration equal approximately to (0.69 CR). For measuring twice per cycle the negative swing of invertor collecter voltage is employed to drive T_{r2} to saturation and obtain a new rectangular pulse on collector of T_{rI}

III. 3. **The AND gate :**

The AND gate circuit is shown in fig. (16). Normally the input to the circuit is of zero voltage value, so transistor T_{rI} is normally off and the output is apporximately at zero voltage. When the whole of the inputs are simultaneously of $-V_{cc}$ value, transistor T_{rI} is on. and output will be of $-V_{cc}$ value. If any of the inputs is zero, T_{rI} will remain cut off.

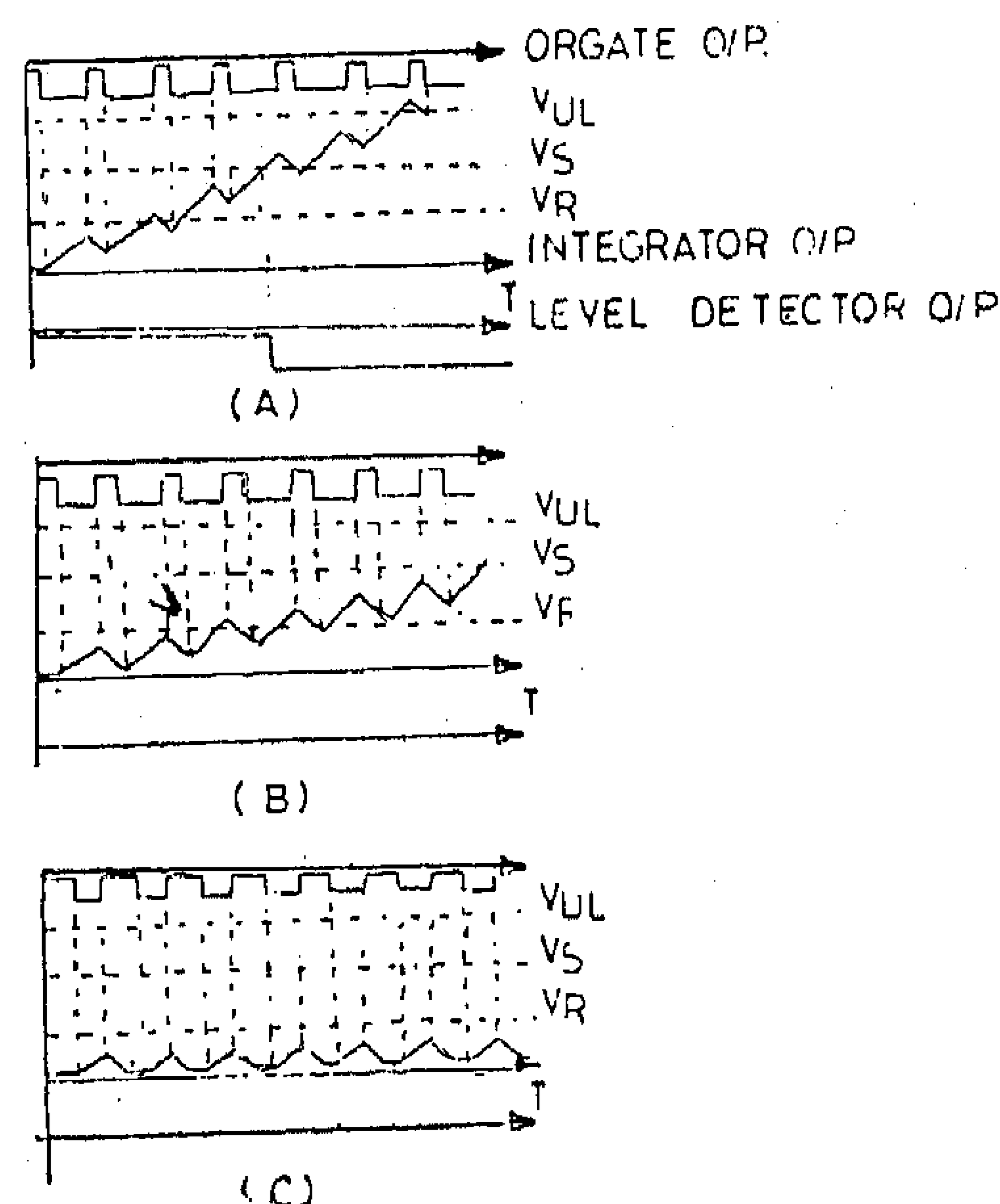


FIG.(11) CIRCUIT ACTION OF BLOCK AVERAGE MODIFIED COMPARATOR (A INSIDE THRESHOLD B AT THRESHOLD C OUTSIDE THRESHOLD)

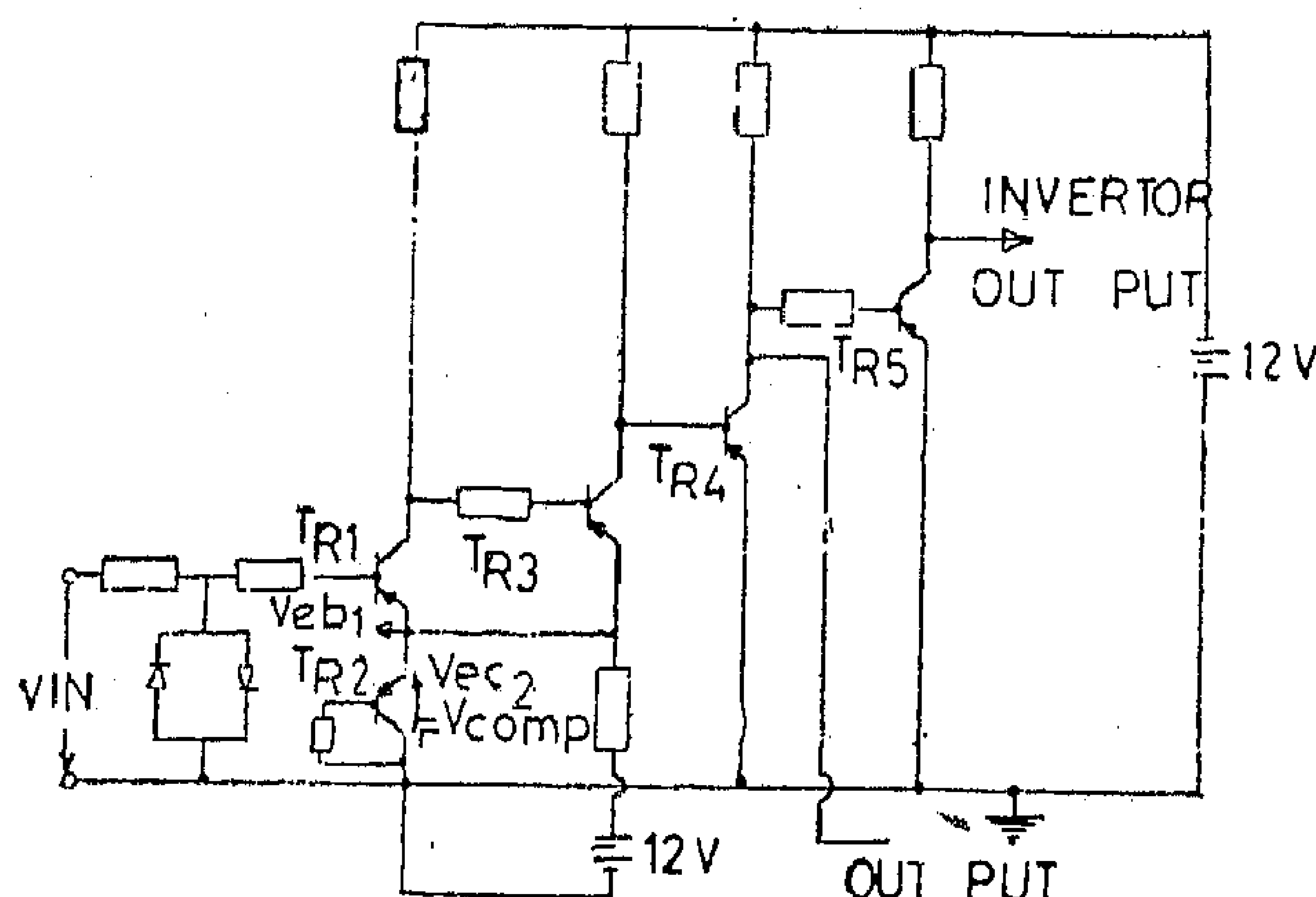


Fig. 12. Zero Crossing detector & inverter

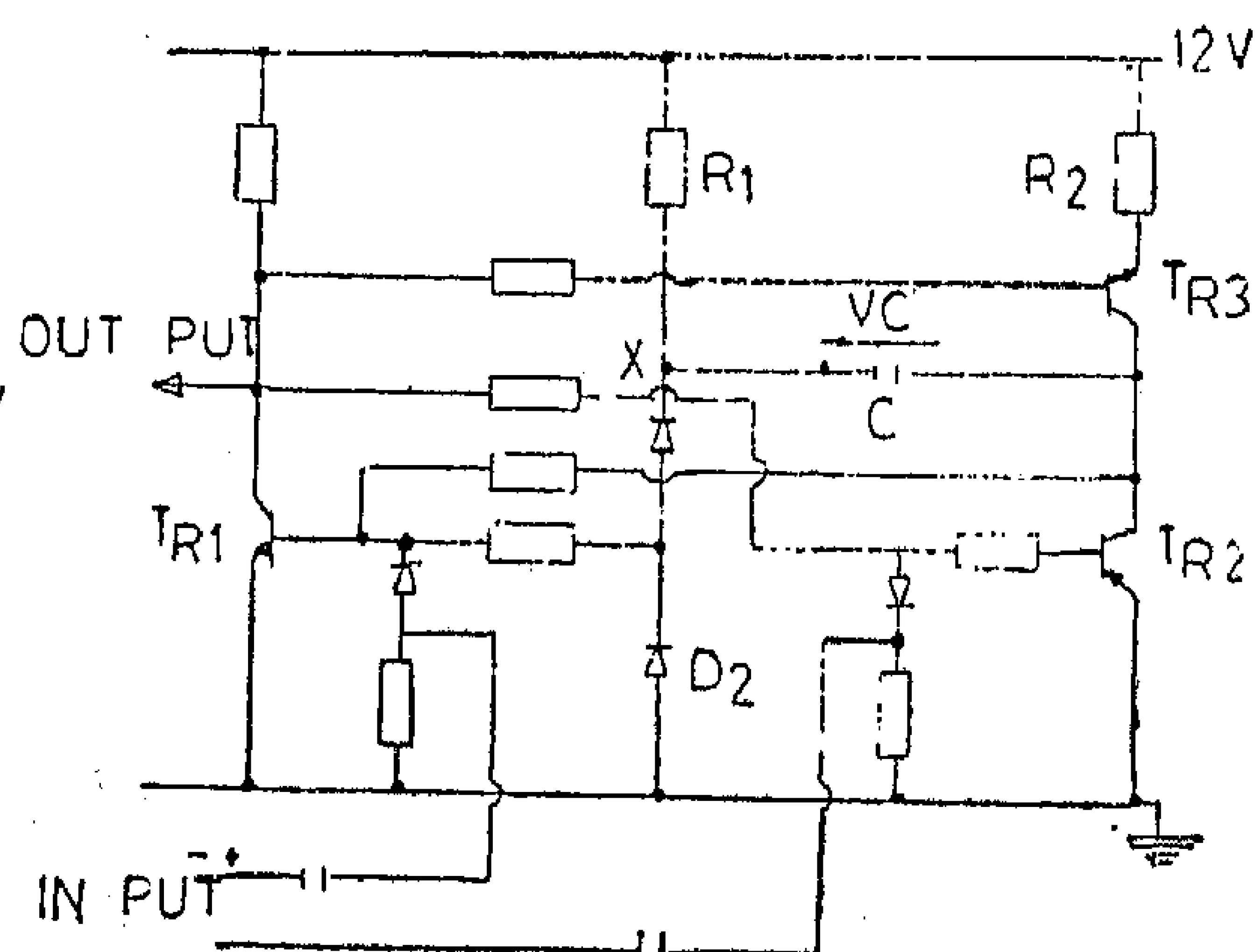


Fig. 13

used. AND gate 1, measures the coincidence period of the last output pulses with the positive coincidence period of the relaying signals, while AND gate 2 measures the coincidence period of the last output pulse with the negative halfcycles coincidence period of the relaying signals, which were taken from the output of the invertor stages (b_1 and b_2), fig. (6). By this arrangement the tendency to false operation due to d.c. component is eliminated.

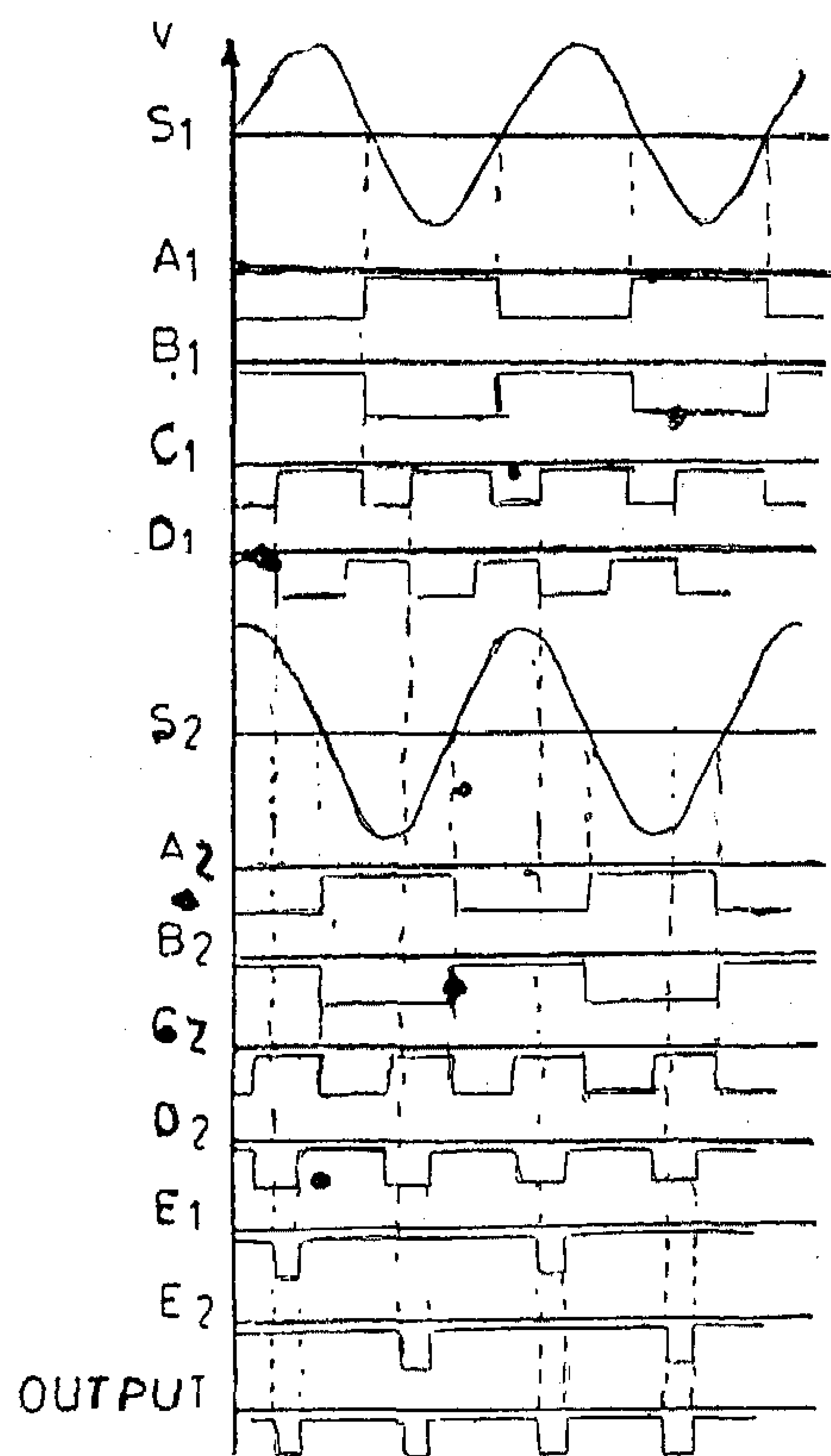


FIG.(10) : CIRCUIT OF COMPARATOR WAREFORMS.

III. Comparator Circuits:

The complete block diagtam of the new 3 - inputs comparator is shown in fig. (6), while the wareforms at different points in the Circuit are shown in fig. (10). Relaying signal S_1 is fed to a zero crossing detector, the output consists of half wave blocks, which are further inverted by 180°, Identification of the zero crossings is effected by differentation the output consists of the signal b_1 at the input to the first quasi-stable or delay circuit, which is adjusted to give pulses at its output equal to the required delay period setting $\theta(S_1)/\omega$ seconds. The second quasi-stable network is actuated from the positive swing of C_1 only, so that a train of pulses, each of required duration

is generated. The same technique is applied to the other signal S in precisely the same manner. The arrangement shown permits measurement twice every cycle. The output of AND gate 1 is seen to be the result of a comparison between negative to posiive zero crossing initiated pulses, and this is achieved by simultaneously comparing each pulse train and the outputs a and a from the zero crossing detectors as indicated. A comparison between positive to negative zero crossings derived pulses is achieved in AND gate 2, by comparing each pulse train and the invertor output signals b_1 and b_2. The OR gate simply comb-ines alternately compared comparison periods to provide the final output of the device. This output is rectangular voltage blocks. The integrating circuit converts these voltage blocks into triangular waveforms, the peak amplitude of which is a measure of the duration of coincidence. The level detector produces an output voltage pulse when its input voltage attains a predetermined level, V_s as shown in fig. (11).

III. 1. Zero-crossing detector and invertor Circuit:

The circuit used is shown in fig. (12). The transistor T_{r2} is arranged to operate in a heavily saturated condition, thus causing its collector-emitter voltage to be highly stabilized and sensibly independent of the current flowing through it from the positive supply. The voltage drop across T_{r2} compensates for the base - emitter voltage drop of the input transistor T_{r1}. If the transistors are similar,

a level detector which has a set value V and a reset value V_r ; which gives an output when the integrator output voltage surpasses a certain level V . The level detector operates the tripping circuit of the line circuit breaker, through an amplifier and a reed relay as shown in fig. (6). The typical generalised block average comparator time response is shown in fig. (7).

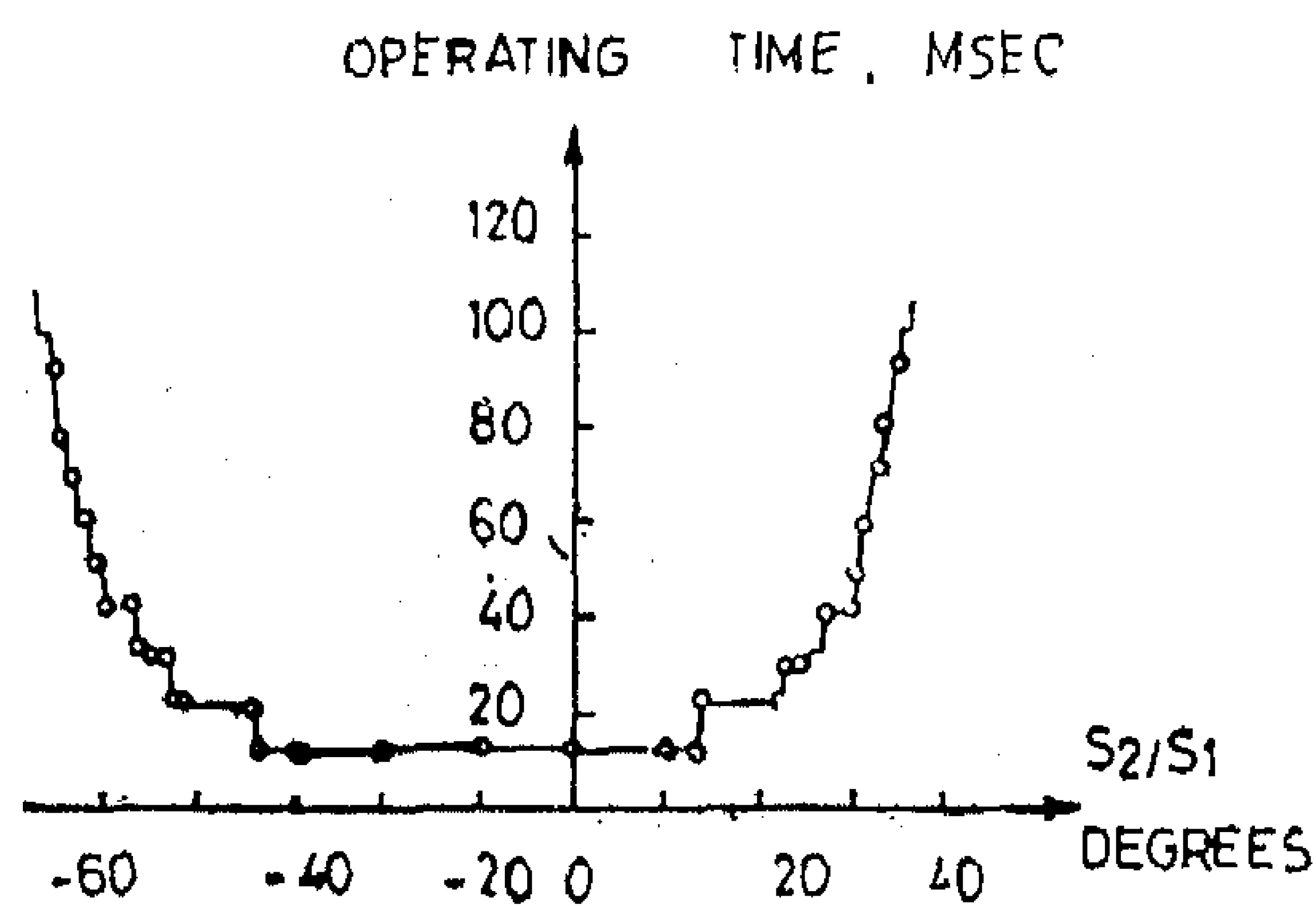


FIG (7) TYPICAL GENERALISED BLOCK-AVERAGE COMPARATOR TIME-RESPONSE

A new technique has been adopted in the new comparator for eliminating the transient over-reach caused by the d.c. component. The method mentioned elsewhere (13) used dual comparators as shown in fig. (8), in which one of the branches measures the period when both S_1 and S_2 are positive, while the other measures the period when both signals are negative. When there is a positive d.c. component in one of the relaysignals, S_1 (or a negative d.c. component), then one of the comparators will give a longer period of coincidence leading to higher voltage output from its integrator, and this may operate the level detector of that comparator but the tendency to false operation of the whole device is prevented by the other comparator which measures the reduced negative period, of coincidence, and an output from the whole device is obtained only if the outputs of the two comparators are coincident as shown in fig. (9). In the new technique, two coincidence circuits were

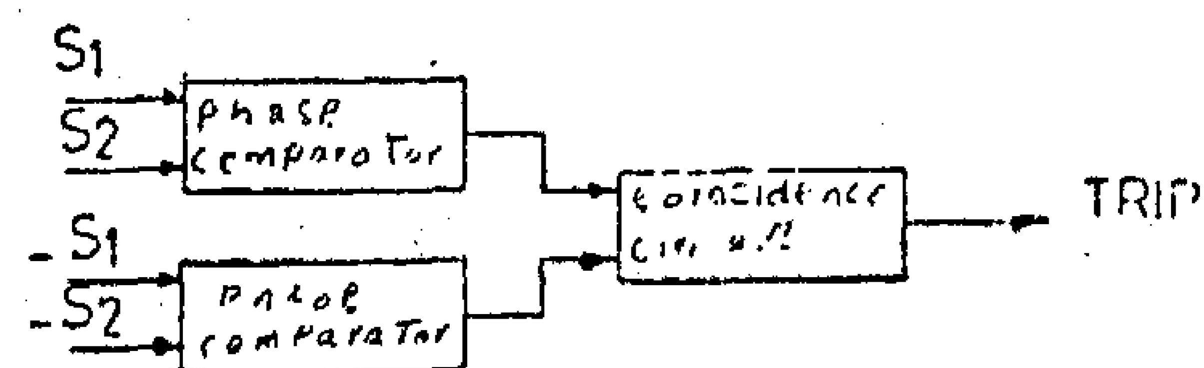


FIG (8) BLOCK DIAGRAM OF DUAL PHASE COMPARATOR.

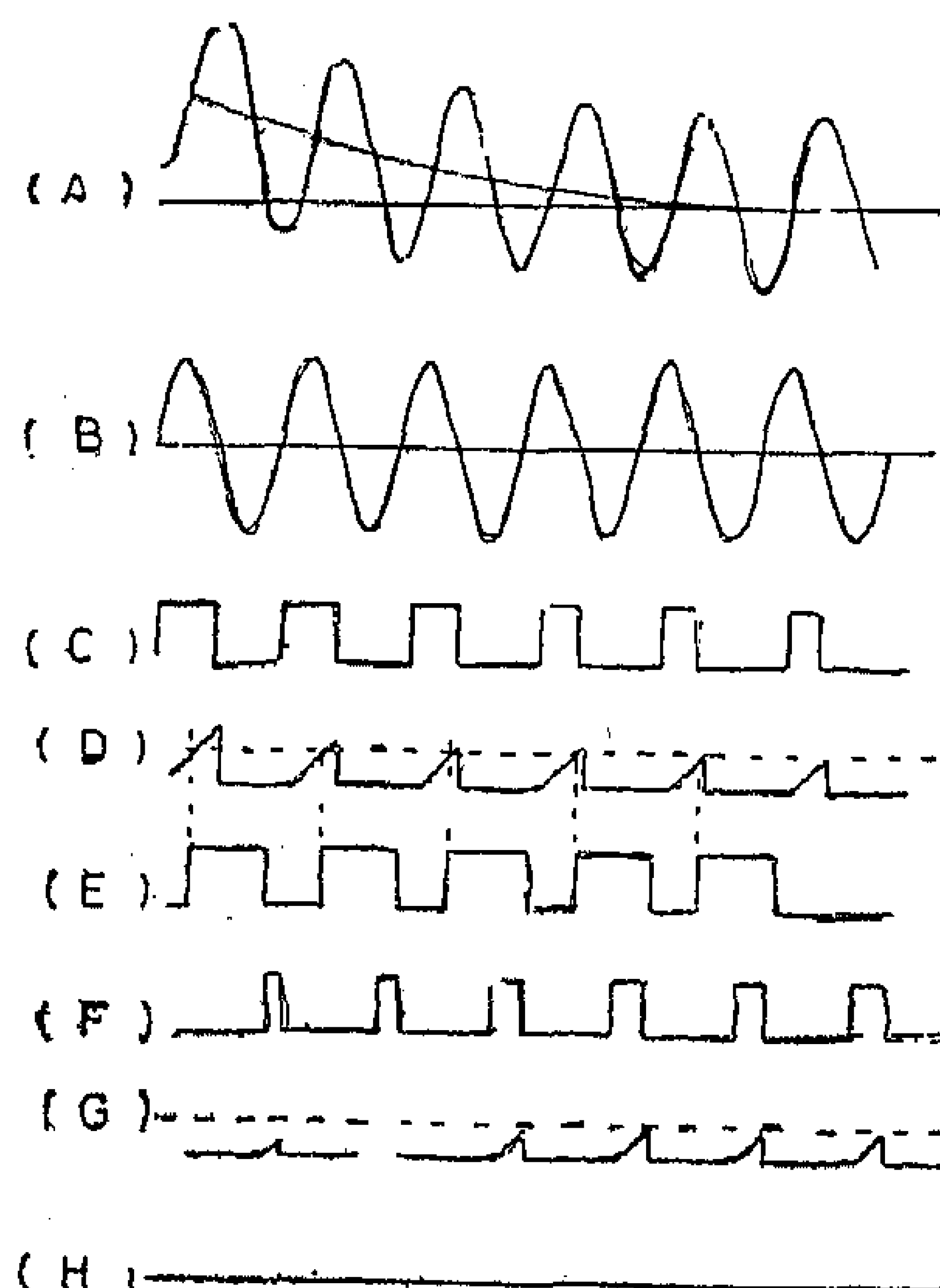


FIG (9) DUAL COMPARATOR WAVEFOMS (A) S1 (B) S2 (C) FIRST COINCIDENCE CIRCUIT OUTPUT (D) FIRST INTEGRATING CIRCUIT OUTPUT (E) FIRST LEVEL DETECTOR OUTPUT (F) SECOND COINCIDENCE CIRCUIT OUTPUT (G) SECOND INTEGRATING CIRCUIT OUTPUT (H) SECOND LEVEL DETECTOR OUTPUT

the signals are compared whthin the comparator circuits.

In the comparator three comparisons are performed as follows :

S_2 and S_I (gives two straight lines CH & CG)

S_2 and S_I (two straight lines OH & OG).

$$-S_{12-} \leq \angle S_2/S_1 \leq S_{12+}$$

$$-S_{13-} \leq \angle S_3/S_1 \leq S_{13+}$$

$$-S_{23-} \leq \angle S_3/S_2 \leq S_{23+} \qquad \text{--------(10)}$$

(two circular arcs with OC as a common chord), as shown in Fig. 4.

The comparator settings and resulting limits of comparison used for the production of the quadrilateral characteristics shown in fig. (4) are merely a function of the protected line constants. The tripping area of the comparator considered in thot area ODCBA.

The new comparator is based on modified block average technique (2, 20). The comparator gives an output pulse of variable duration according to the phase difference between the two imput signals.

To illustrate its performance, the time at which the output pulse starts and finishes relative to the negative — to — positive zero crossing of one relaying signals is plotted against the phase angle between the relaying signals Such presentations are referred to as time phase contours (2) as shown in fig. (5). The output pulse passes through an integrator whose voltage rises at a rate K_n volts per second. When there is no output pulse the integrator voltage falls at a rate K_n volts per second. Then the change in the integrator voltage in any halfcycle is

$$V_I = K_c \, t_c - K_n \, t_n \qquad (11)$$

At threshold conditions $V_I = O$. The output of the integrator goes through to

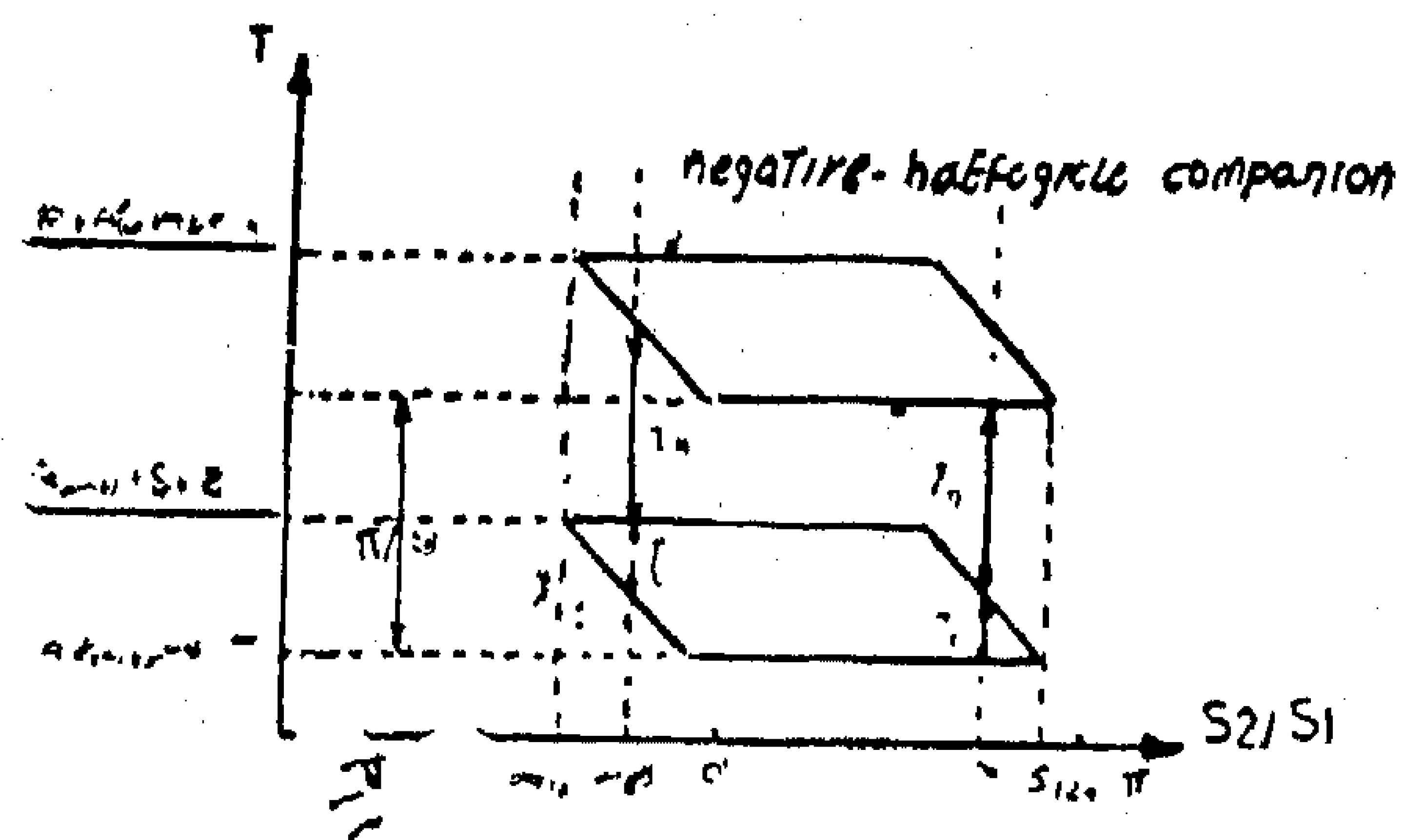


FIG.(5) OUTPUT PERFORMANCE OF COMPARATOR WHICH MEASURED TWICE PER CYCLE

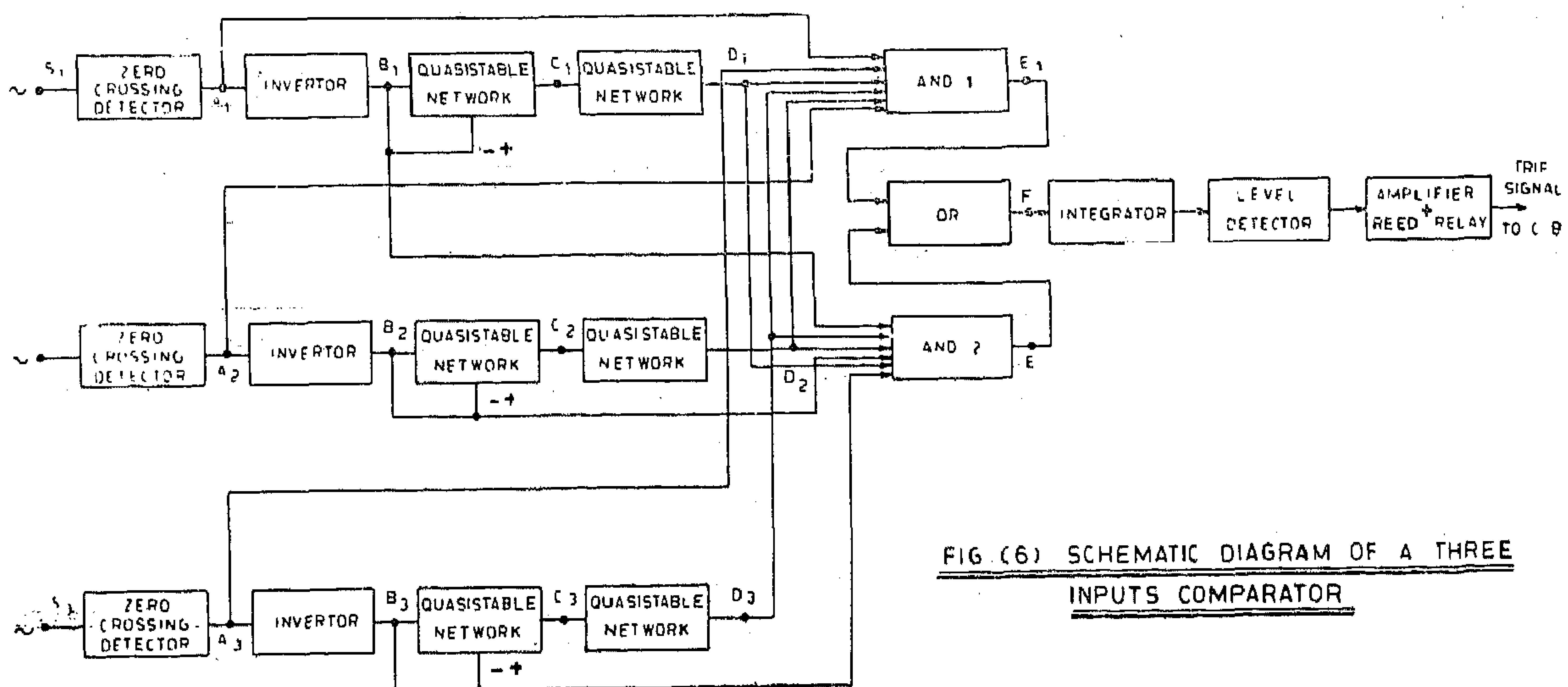


FIG (6) SCHEMATIC DIAGRAM OF A THREE INPUTS COMPARATOR

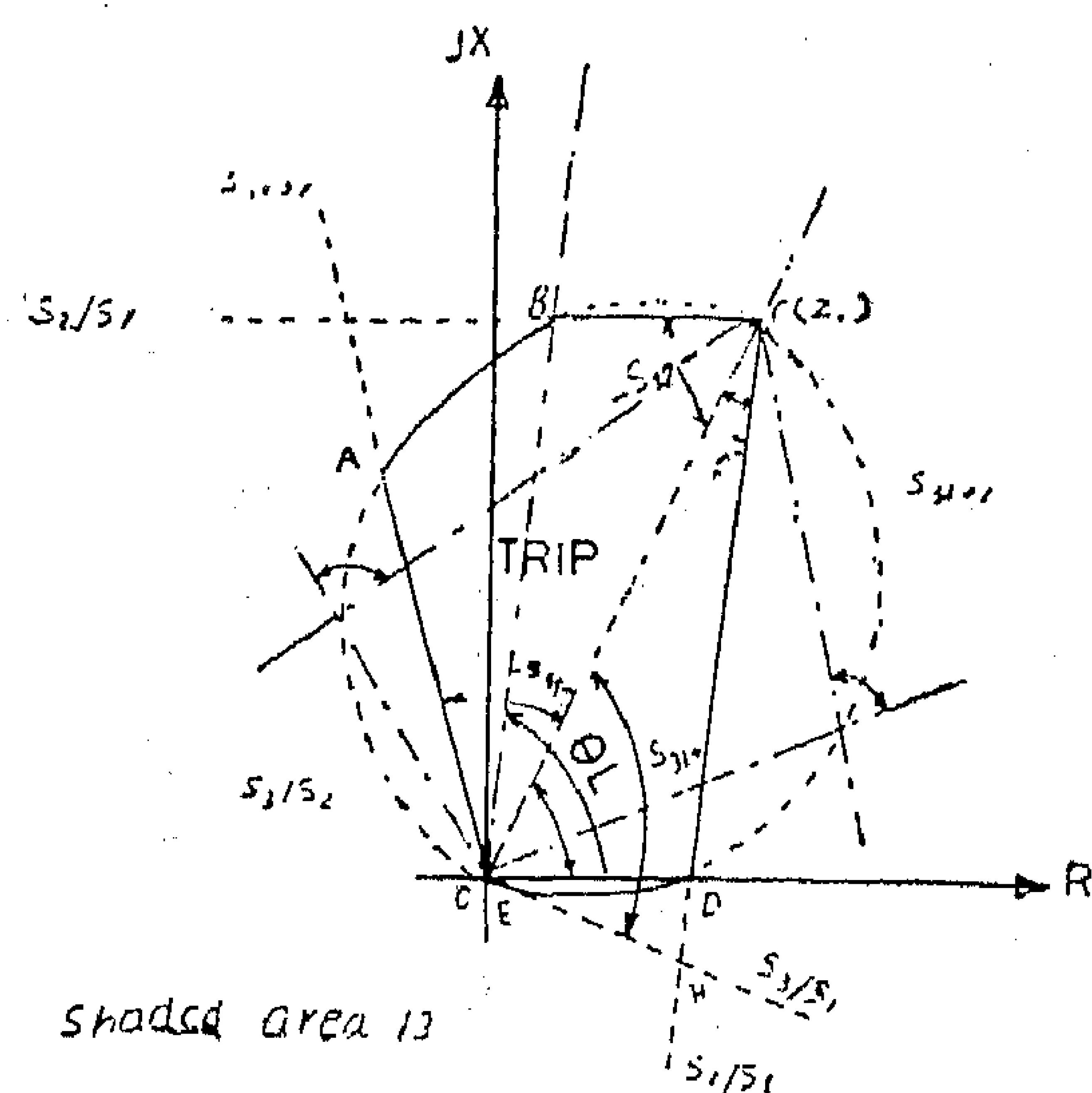


FIG.(4). TYPICAL POLAR CHARACTERISTIC PRODUCED BY 3 INPUT COMPARATOR

$$- S_{12}- = S_2/S_1 = \theta(S_2) - \theta(S_1) - \delta(S_1) \quad (2)$$

Similarly, the threshold condition which results when S_2 leads S_1 is given by:

$$S_{12}+ = S_2/S_1 = \theta(S_2) - \theta(S_1) + \delta(S_2) \quad (3)$$

S_{12} +is called the positive limit of comparison. The complete operating criterion is defined by eqn.

$$- S_{12}- \leq \angle S_2/S_1 \leq S_{12}+$$

or

$$\theta(S_2) - \theta(S_1) - \delta(S_1) \leq \angle S_2/S_1 \leq \theta(S_2) - \theta(S_1) + \delta(S_2) \quad (4)'$$

Consequently, Equation 4 gives the characteristics obtained by comparing two signals S_1 ant S_2.

Assume that — S12- = and S_{12} + = it may be verified that the characteristics equation for the — limit is given by:

$$\alpha \geq \angle S_2/S_1$$

Let the two signals S and S_2 be given by

$$S_1 = K_1 V_1 + K_2 I_1 \quad (5)$$

$$S_2 = K_3 V_1 + K_4 I_1 \quad (6)$$

where V_1, I_1 are the line voltage and current respectively. K_1, K_2, K_3, and K_4 are in general complex quantities. Let;

$$\frac{V_L}{I_L} = R + jX \qquad \frac{K_2}{K_1} = a + jb$$

$$\& \quad \frac{K_4}{K_3} = c + jd$$

Equation 4' may be written in the following form:

$$R^2 + X^2 + R\left[(a+c) + (b-d)\cot(\alpha - \angle K_3/K_1)\right] + X\left[(b+d) + (c-a)\cot(\alpha - \angle K_3/K_1)\right] + (cb - da)\cot(\alpha - \angle K_3/K_1) \geq 0 \quad (7)$$

This is an equ. of a circle in the R-X plane. Similarly another circle for the characteristics of the negative limit is deduced. These two circles have common chord between the points (-C, — d) and (— a, — b) as shown in Fig. (2). A straight line characteristics are obtained by setting K_1 or K_3 to zero. For K_1= O the characteristics for both positive and negative limit of comparison are as follows:

$$x \geq R_{tan}(\angle k_3/k_2 - \alpha) + c_{tan}(\angle k_3/k_2 - \alpha) - d \quad (8)$$

$$\text{and } x \geq R_{tan}(\angle k_3/k_2 - \beta) + c_{tan}(\angle k_3/k_2 - \beta) - d \quad (9)$$

The two straight lines pass through the point (-C, -d) as shown in fig. (3). Hence, it is chearly seen that the characteristic can be shaped as required by varying K_1, K_2, K_3, and K_4.

11.2. Malti-input comparators (21)

More than two signals may be compared in a multi-input comparator; For a 3 - input comparator, with the following infeed signals :

$$S'_1 = I_1 Z_r$$

$$S'_2 = I_1 Z_r - V_1$$

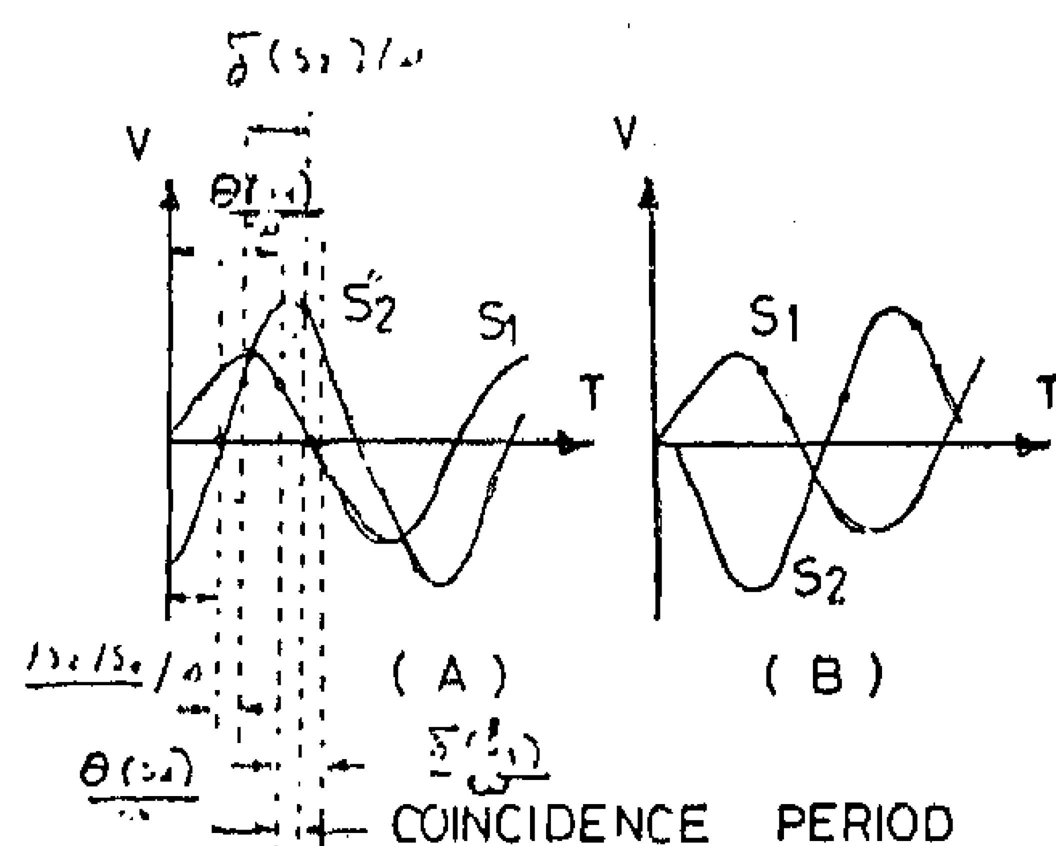
$$S'_3 = V_1$$

Phase comparison techniques can be used to obtain conventional mho characteristic (12, 19), where the coincidence block average method of phase comparison (20) ensures dynamic accuracy. The basic theory and principle of operation of a new method of phase comparison for use in distance protection schemes will be outlined. However, the number of the imputs to the conventional coincidence block average technique is restrictet to two with angular limits of comparison confined to + 90°, the new comparator is a multi-input device, whose angular limits of comparis on are not 90° and are asymmetric and may be varied by changing the setting of the delay circuits. The block average method was modified in such a way that improved characteristics have been obtained. The output of the device progresses from a short duration pulse at the threshold to one of fixed duration according to phase difference between the compared signals.

II. Use of phase comparison technique for distance protection:

II.1. Phase comparison technique

The new comparator is based on the phase comparison technique. The input to the comparator is the vectorial sum or difference of two voltages derived from the protected circuit. For two input signals to the comparator S_1 and S_2 the output of the comparator exists if the phase angle ψ between the two signals satisfies the equation: $\lambda \angle \psi \angle \lambda$ This is the general equation for the characteristic of the comparator on the complex plane. The angles and $-\lambda$ are called he comparison limits. In the new comparator, the comparison limits are asymmetrical. For each signal there are a delay period θ (s) and a comparison periot δ (s). For two input signals S_1 and S_2, with S_2 lagging S_1 and taking S_1 as the reference as shown in Fig. 1, the negative limit of comparison is given by :



FIG(1): GENERALISED COMPARISON OF TWO SIGNALS
(A) TRIP (B) BLOCK

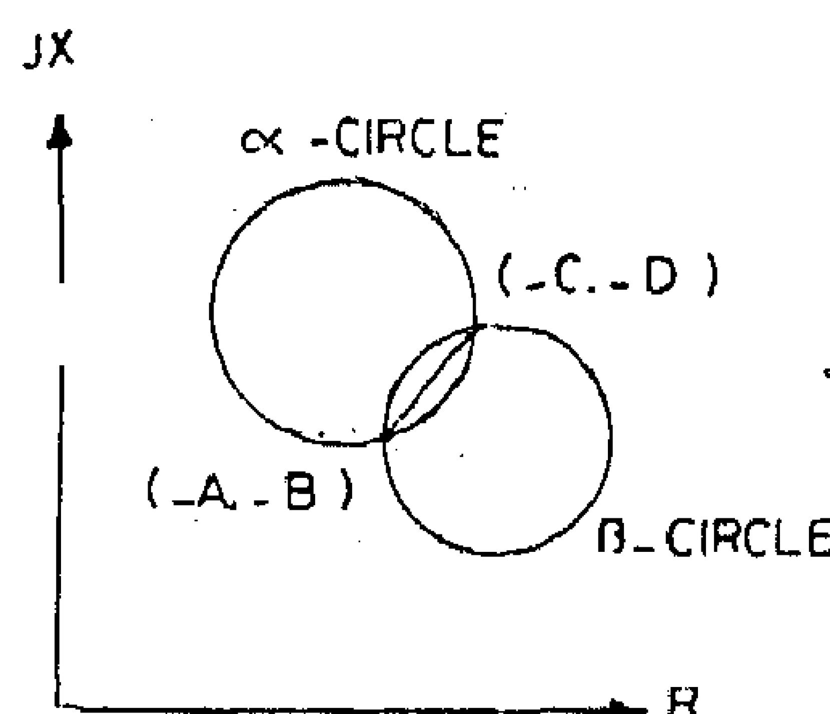


FIG.(2) CHARACTERISTICS OF TWO INPUTS COMPARATOR, WITH S_1 AND S_2 IN THEIR GENERAL FORM

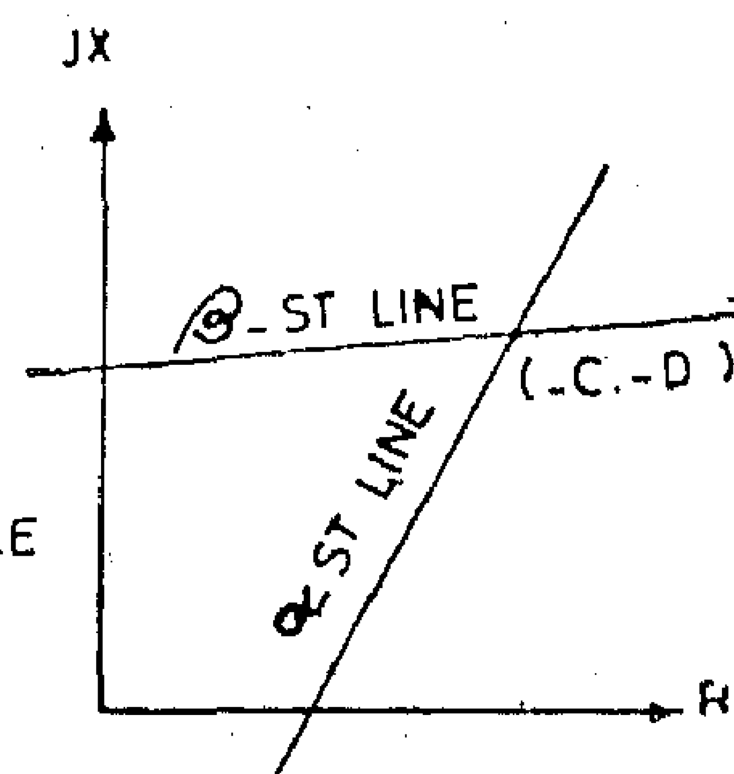


FIG.(3) CHARACTERISTICS OF TWO INPUTS SUITABLY, CHOSEN COMPARATOR

A FULLY STATIC DISTANCE RELAY FOR THE PROTECTION OF E.H.V. LINES

By

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SUMMARY: This paper outlines the fundamental bases of using new phase comparison techniques in the distance relays for high voltage transmission lines. Among the complex polar characteristics for the distance relays which were already developed, the quadrilateral characteristic had proved its superiority to the other alternatives, since it enables accurate coverage for the fault arc resistances enrountered in practice, together with its immunity to false operation during heavily loaded conditions with wider stable region during phase swings.

A distance relay based upon the phase comparison principles, using the modified block average technique, was desingned. This work illustrates; its circuitry and performance during abnormal cond itions which arises in power networks. A full medel has been built in Cairo Unievrsity, Faculty of Enbineering. The test results proved that the required characteristic has been achieved.

Definit ions & previous work:

Static relay may be defined either as:

a) the one in which the measurement or comparison of electrical quantities is performed in a static circuit which is designed to give an output signal for tripping when a threshold condition incurred. The output signal operates a tripping device which may be electronic, semiconductor or electromagnetic (1).

Or

b) As the B.S.I. definition, which refers to static relay as the one with "No moving parts".

The earliest documented work on electronic static relay was that of Rolf-Wideroe (3, 4). Semiconductor rectifier comparators were studied later by many authors (5, 6, 7, 8, 9), while transistor relays were studied elsewhere by others (10, 11, 12, 13, 14, 15).

I. Introduction

Interest recently centres on new shapes of polar characteristics to improve the discriminative performance of distance relays applied to heavily loaded lines. It is generally accepted that the quadrilateral characteristics (16) is superior to the simpler alernatives for these purposes. Several methods for the production of quadrilateral characteristics have been suggested (17, 18); but the results was a complexity in the circuits coupled with a poor dynamic response.

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duration of the over-voltage, represented by Curves (b). However, the area between the two curves at the right of the intersection point represents the condition of flashover because the minimum time required for flashover, represented by curves (a), is less than the actual duration of the over-voltage, represented by curves (b)

Figures also show that switching surges are of dangerous effects, causing flashover on the insulators, for pollution severities between 6.6 and 19.5 us for the line part between Cairo and Samalout. This dangerous effect on the line part between Nag-Hammadi and Aswan appears at pollution severities as low as between 1.4 and 9.5 us.

5. Conclusions :

The present analysis shows that the insulators of the 500 KV Aswan-Cairo line are expected to flashover, even under the normal operating voltage if the pollution severity exceeds about 20, 12 and 10 us for the line parts Cairo — Samalout, Samalout — Nag-Hammadi and Nag-Hammadi — Aswan respectively. Under switching off condition, the line insulators are expected to flashover at much lighter pollution conditions. The insulator of the line part between Cairo and Samalout are expected to flashover as the pollution severity exceeds about 7 us. The insulators of the line part between Nag-Hammadi and Aswan, are expected to flashover as the pollution severity exceeds only about 2 us. Meanwhile, switching off surges are found of no effect on the insulators of the line part between Samalout and Nag-Hammadi.

It is hoped that further investigation will also define these criteria under switching on surges while the line is energised at its maximum voltage. It is also hoped that the authorities of the General Egyptian Electricity Corporation make use of the present study in scheduling the live line washing for the aim of preventing supply interruptions due to insulation flashover events.

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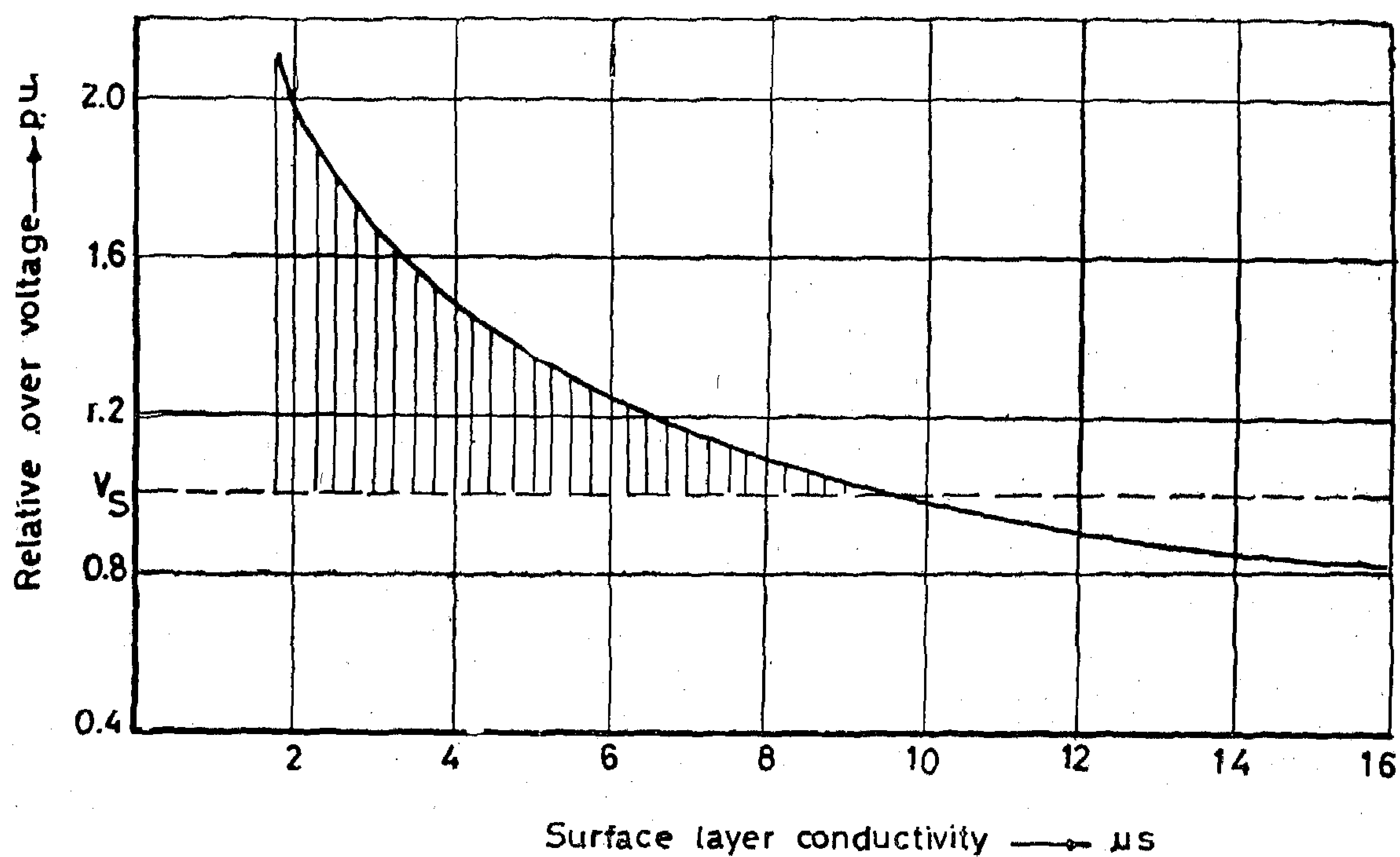


Fig.(8): Relation Between Relative Over Voltage and Layer Conductivity for Line Part Between Nag-Hammadi and Aswan.

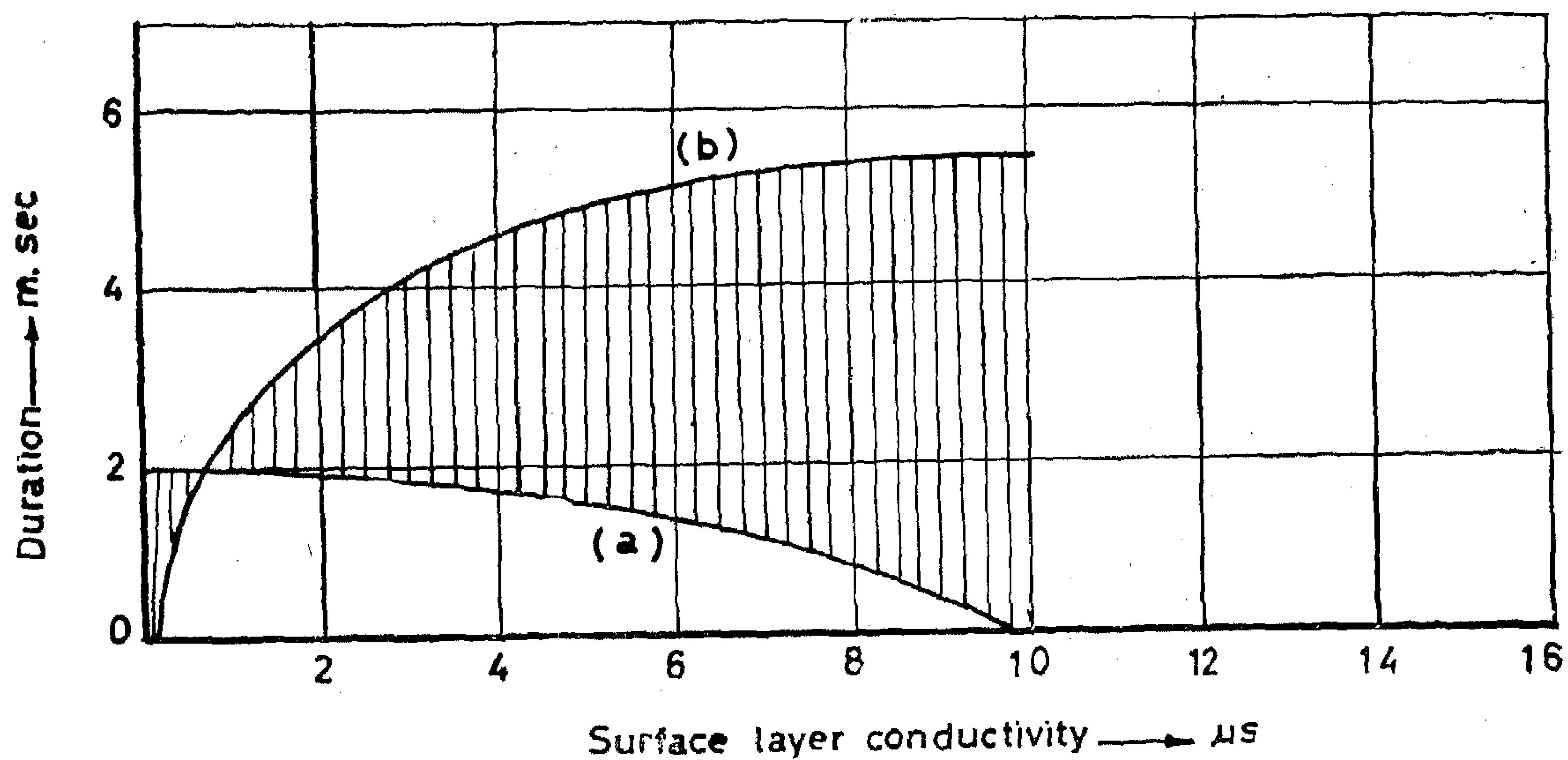


Fig.(9): Relation Between The Duration Of Over Voltage and Layer Conductivity.

a) From V_m-X Charts b) From Switching off Surge at Nag-Hammadi.

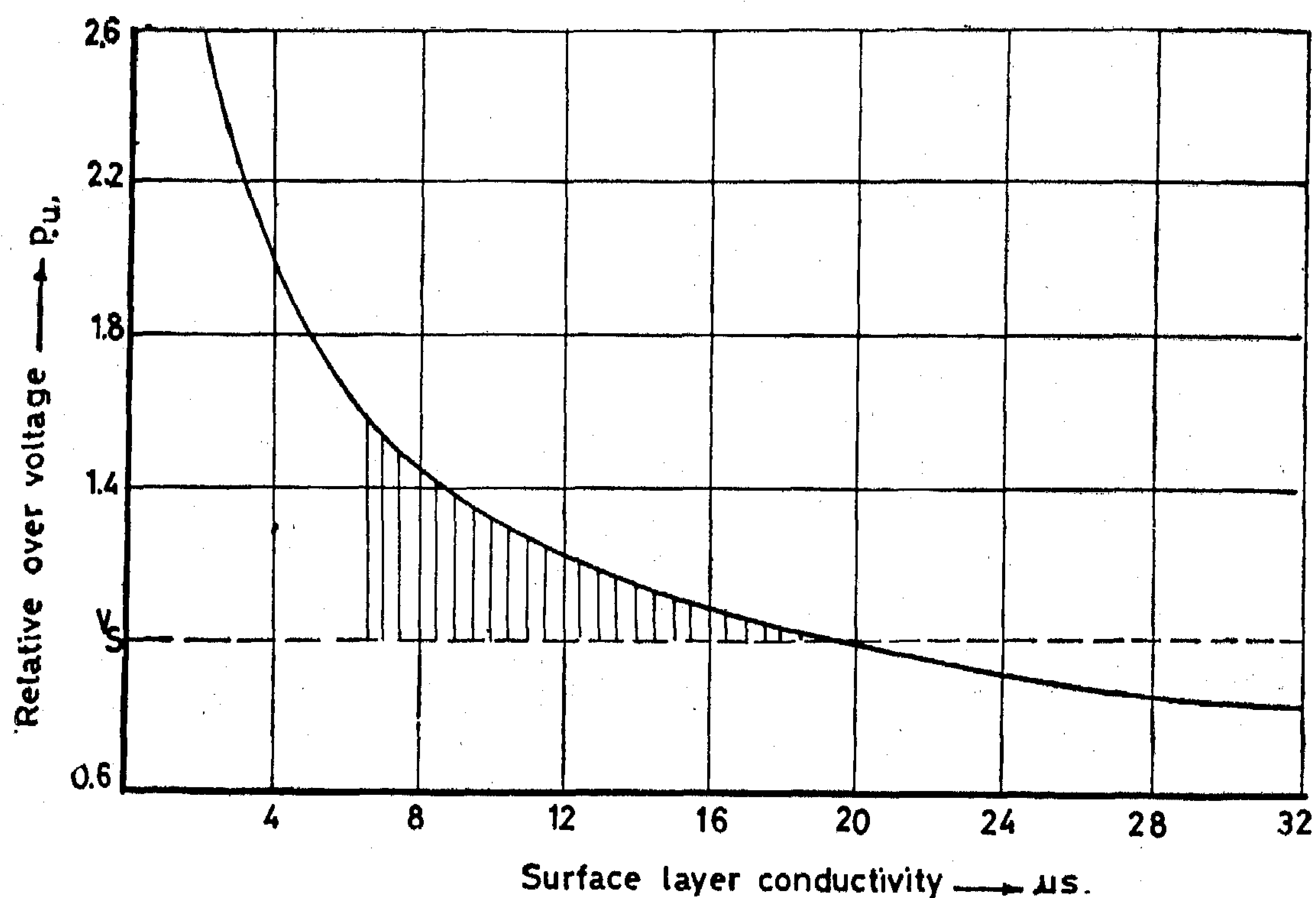


Fig.(6): Relation Between Relative Over Voltage and Layer Conductivity for Line Part Between Cairo and Samalout.

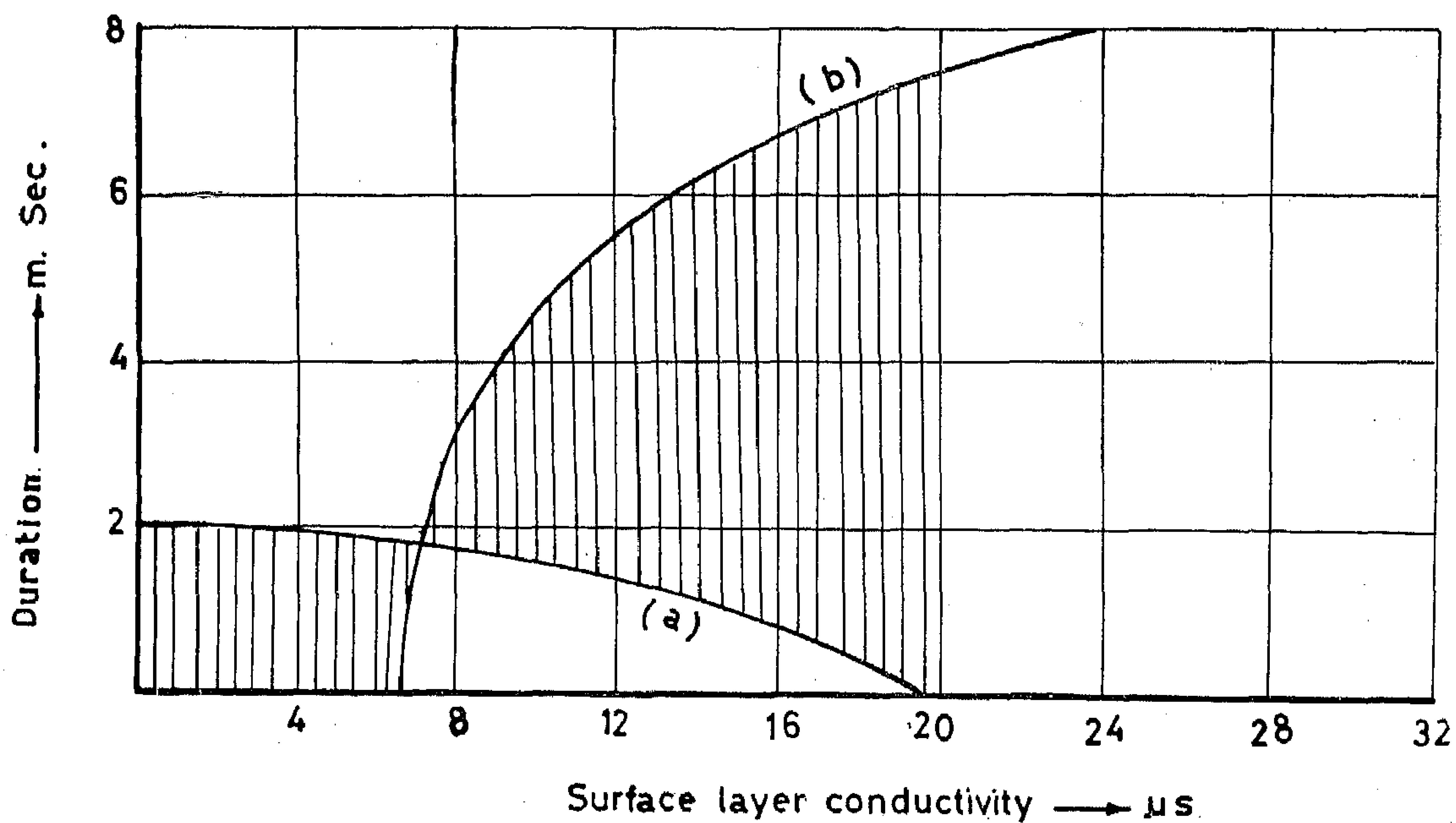


Fig.(7): Relation Between the Duration of Over Voltage and Layer Conductivity.

a) From V_m - X Charts b) From Switching off Surge at Cairo.

ing that the average velocity of arc propagation is 10 cm/m. sec.11.

4.3 Performance of the 500 KV Aswan-Cairo Line Insulators :

The relation between (V_m) and (X) being defined for the line insulator type used in the 500 KV Aswan- Cairo line, Fig. (5), the line insulation performance can be predicted, Assuming that the voltage is uniformly distributed over the polluted string12, hence, the voltage per unit insulator would be

$$V_s = \frac{V_{max}}{N} \qquad (10)$$

where V_{max} is the peak cyclic value of the phase voltage (408 KV).

N is the number of insulator units per string.

The number of insulator units per string in the regions of the 500 KV line between Cairo and Samalout, Samalout and Nag-Hammadi and between Nag-Hammadi and Aswan are 36, 30 and 27 respectively. Hence, the voltage per insulator unit will be V_{s1} =11.35, V_{s2} =13.6 and V_{s3} = 15.14 KV/unit, for the above regions respectively.

The intersection points between (V_{s1}), (V_{s2}) and (V_{s3}) with (X_c), would indicate the maximum permissible values of pollution layer conductivity, before flashover can occur under the normal power frequency voltage, Fig. (5). Figure (5) thus shows that the pollution severities should not exceed 19.5, 12.5 and 9.75 us for the line parts between Cairo and Samalout, Samalout and Nag-Hammadi and Nag-Hammaid and Aswan respectively.

During switching operations, over-voltage surges, of shapes, amplitudes and durations as indicated by Figs. (2), (3) and (4) for the above mentioned regions are applied to the line insulations.

Now, the relations between the duration of the over-voltage required to complete the flashover over the insulator surface and the surface layer conductivity can be determined graphically using the graphical relation of Fig. (5) between (V_m) and (X), for different values of layer conductivity σ_s These relations are represented by the Curves (a), of Figs. (7) and (9), for line parts between Cairo and Samalout and between Nag-Hammadi and Aswan respectively. Also, for each value of surface layer conductivity, the over-voltage must exceed the critical withstand voltage (V_c), determined from Fig. (5). So, the relation between the over-voltage value required for flashover occurence and surface layer conductivity can be also determined graphically. Figs. (6) and (8) represent the relations between the relative over-voltage (V_c /V_s) versus surface layer conductivity for line parts between Cairo and Samalout and between Nag-Hammadi and Aswan respectively. Hence, the value of critical withstand voltage (V_c) at different values of layer conductivity canbe obtained for the insulator string.

From the voltage wave shapes for the various line parts between Cairo and Samalout and between Nag-Hammadi and Aswan, the actual durations for each value of these over-voltages V_c)can be obtained. Curves (b) in Figs (7) and (9) represent the relations between these durations and the surface layer conductivity for the previously mentioned line parts respectively.

Figures (7) and (9) show that the intersection between the two curves (a) and (b) gives the condition of flashover on the line. The area to the left of the intersection point represent the condition of no flashover because the minimum time required for flashover, represented by Curves (a), is greater than the actual

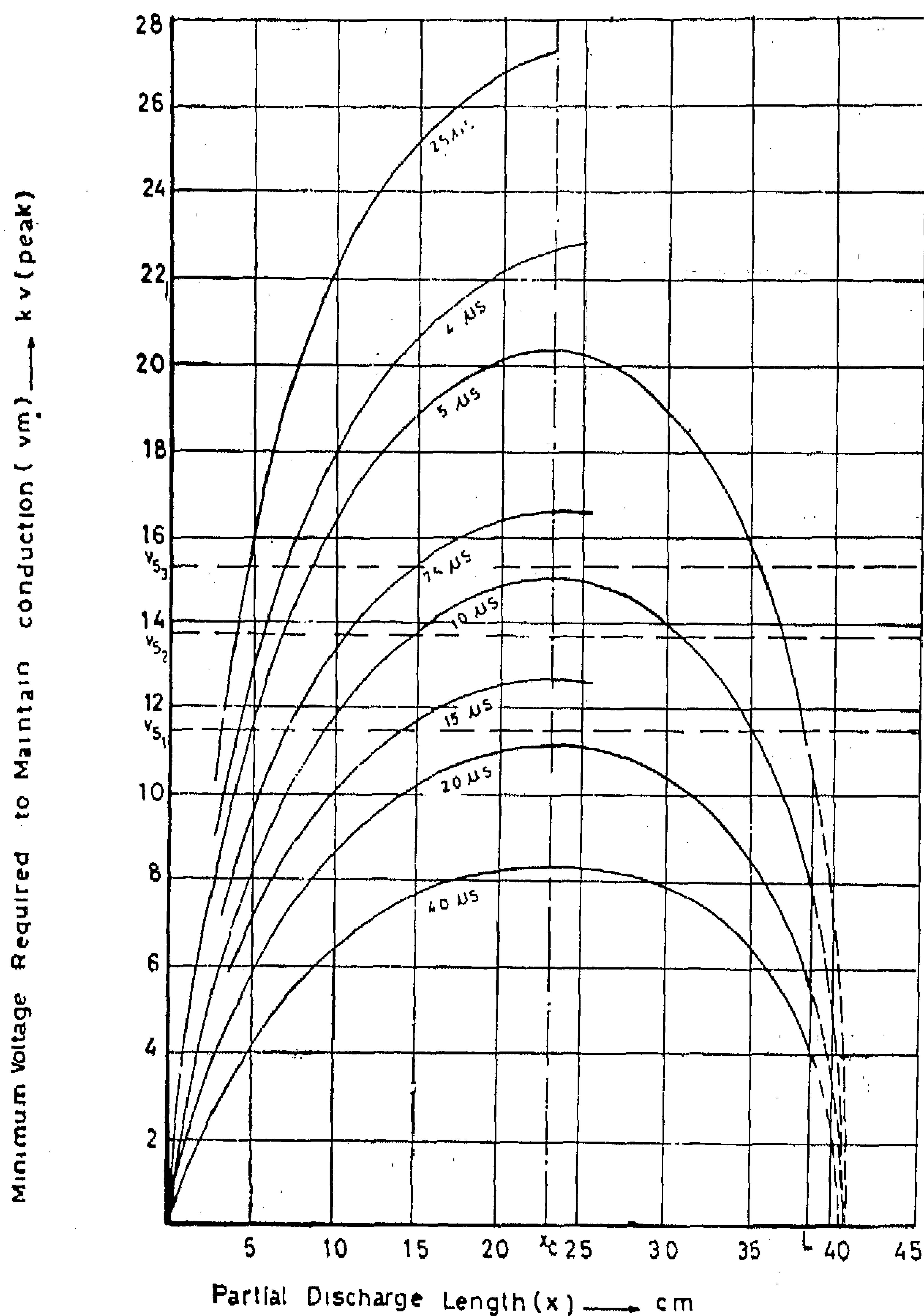


Fig.(5): Relation Between (V_m) and (X) for Cap and Pin Insulator, Type PFE 11.

The worst conditions under which the polluted insulators of the 500 KV Aswan-Cairo line operates, would be when a switching surge, superimposed on the normal power frequency voltage is applied to the insulator. In this case, a polluted insulator will initially attain a partial discharge of length (X_s) burning in series with the polluted layer of length ($L - X_s$), under the normal power frequency voltage (V_s), Fig. (5), and before the swithching surge is produced8-10. When the switching surge is produced, this partial arc tends to propagate under the effect of the over-voltage.

Flashover would thus occur provided that the amplitude of the transient voltage wave exceeds the critical value of the withstand voltage (V_c), and its duration is greater than the time required for the partial arcs to propagate a distance (X_c-X_s), where (X_c) is the critical insulator length to be bridged by partial arcs before complete flashover could occur8-10 know-

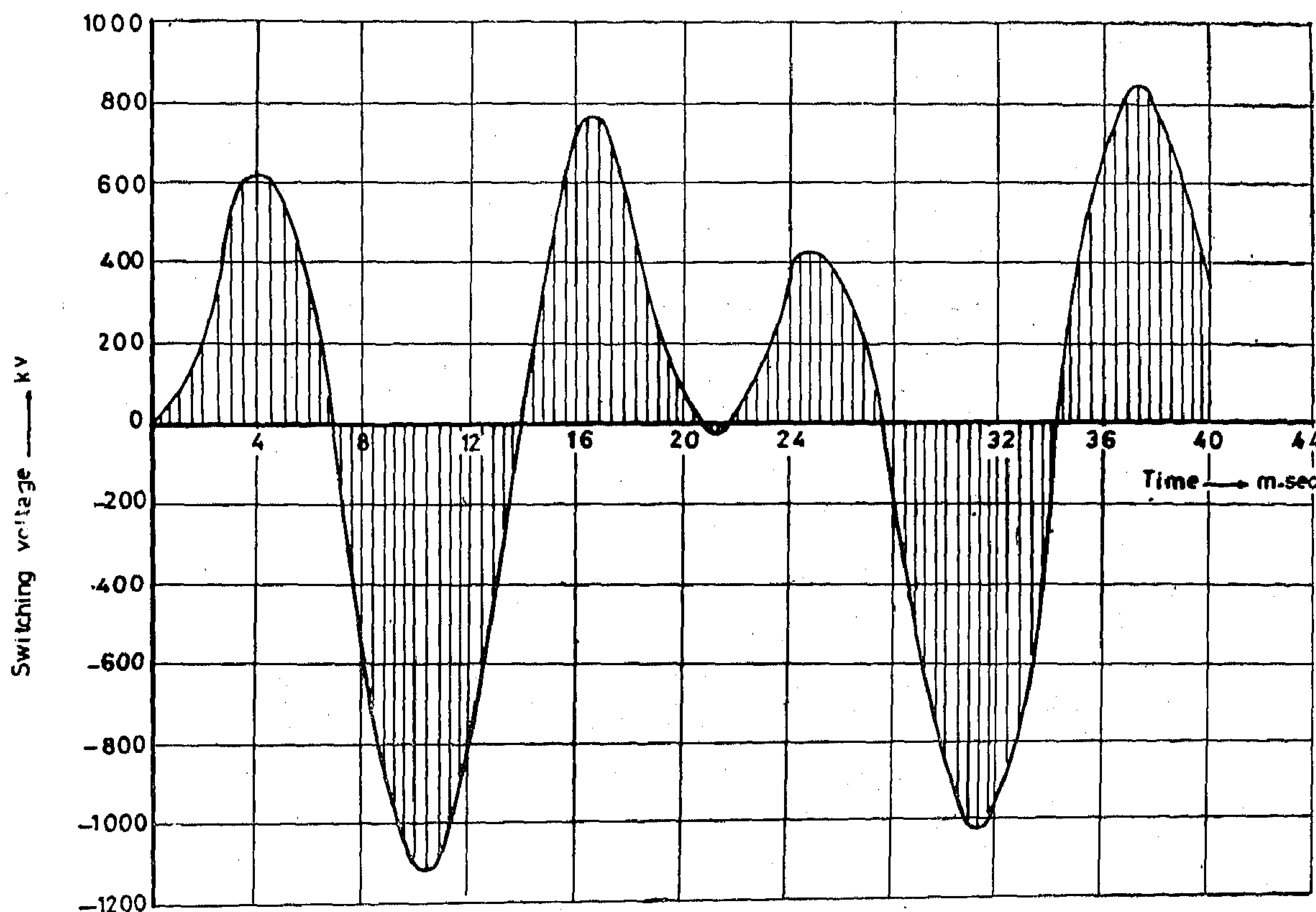


Fig.(4), Switching Off Surge at Nag-Hammadi.

where r_p is the pollution layer resistance per unit length (ohm/cm)

A and n are the arc constants and have the values 63 and 0.76 respectively10

a,b and c are dimensionless factors depending on the arc characteristics and the insulator dimensions 8,9.

L is the total creepage length of an insulator unit (L=38.4 cm for cap and pin insulator type used in the line.

Also, the critical discharge length (X_c), corresponding to the critical withstand voltage (V_c), which is the maximum value of (V_m), has been calculated as :

$$X_c = \frac{L}{(1+n)(1-bc)} \qquad (8)$$

The factors a, b and c of equations (7) and (8) have been defined experimentally for the cap and pin insulator type Pfell used for the 500 KV Aswan Cairo line insulation9.

Thus, the relation between the minimum voltage required to maintain conduction (V_m) and the arc length (X) along the polluted insulator surface, for the above type of line insulator, reduces to :

$$v_m = 28.8\,(X)^{0.57}\,(38.4-0.95\,X)^{0.43}\,(r_p)^{0.43}\cdot v\,(\text{peak}) \qquad (9)$$

Figure (5) shows this relation for different values of pollution layer conductivity (σ_s

4.2 **Effect of Surges on the Discharge Growth Criteria on the Polluted Line** Insulators :

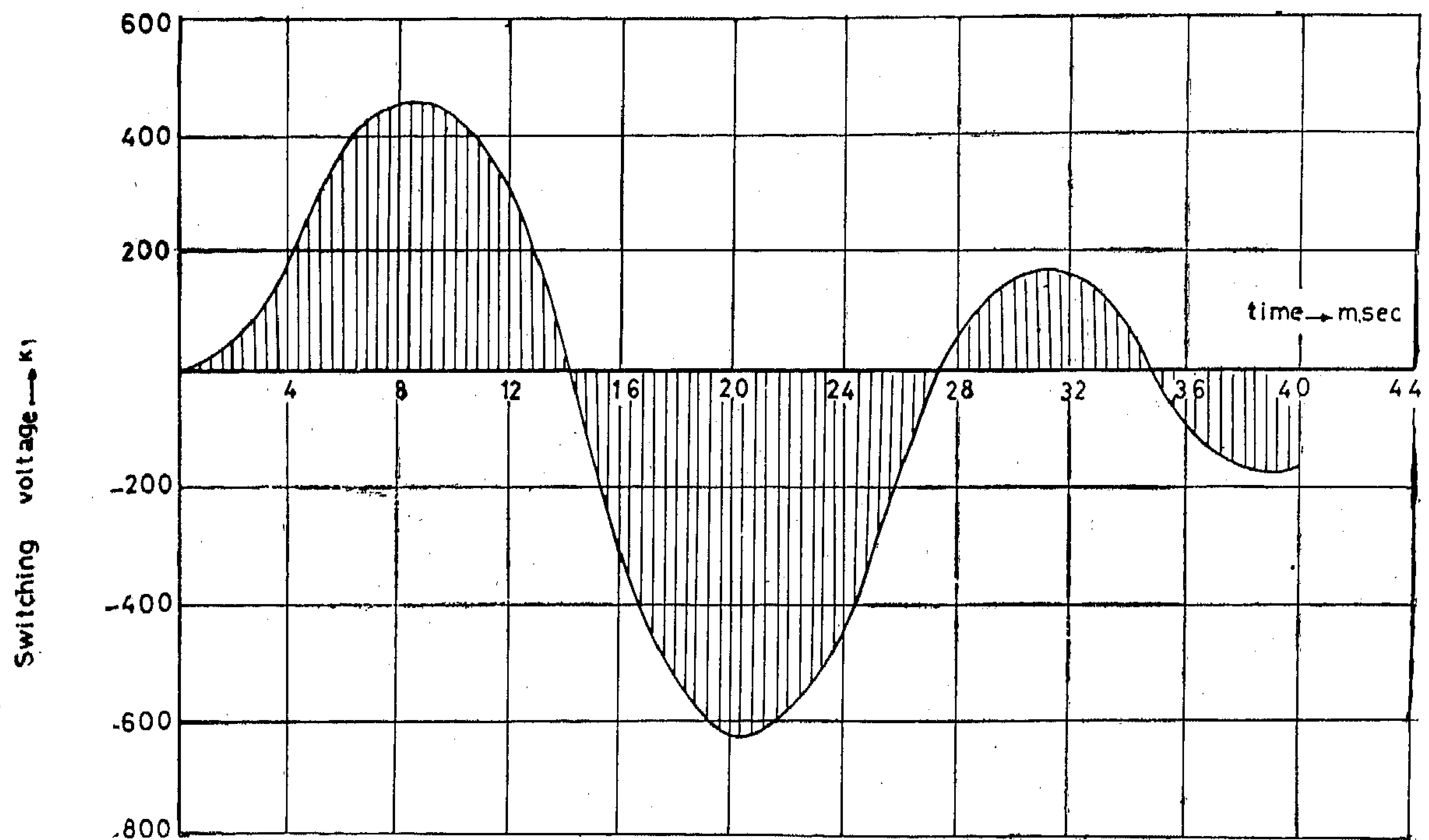


Fig.(2): Switching Off Surge at Cairo.

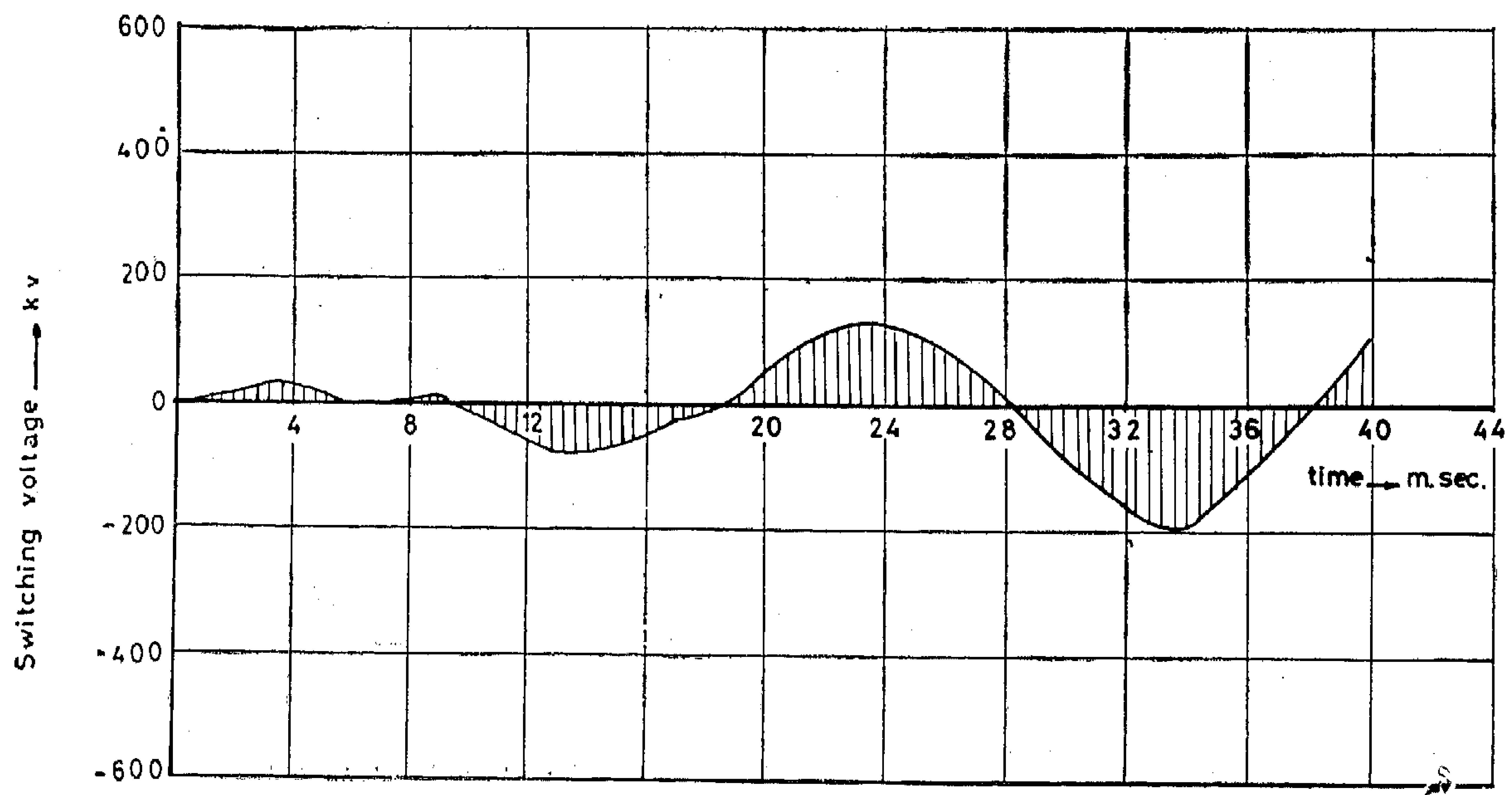


Fig.(3): Switching Off Surge at Samalout.

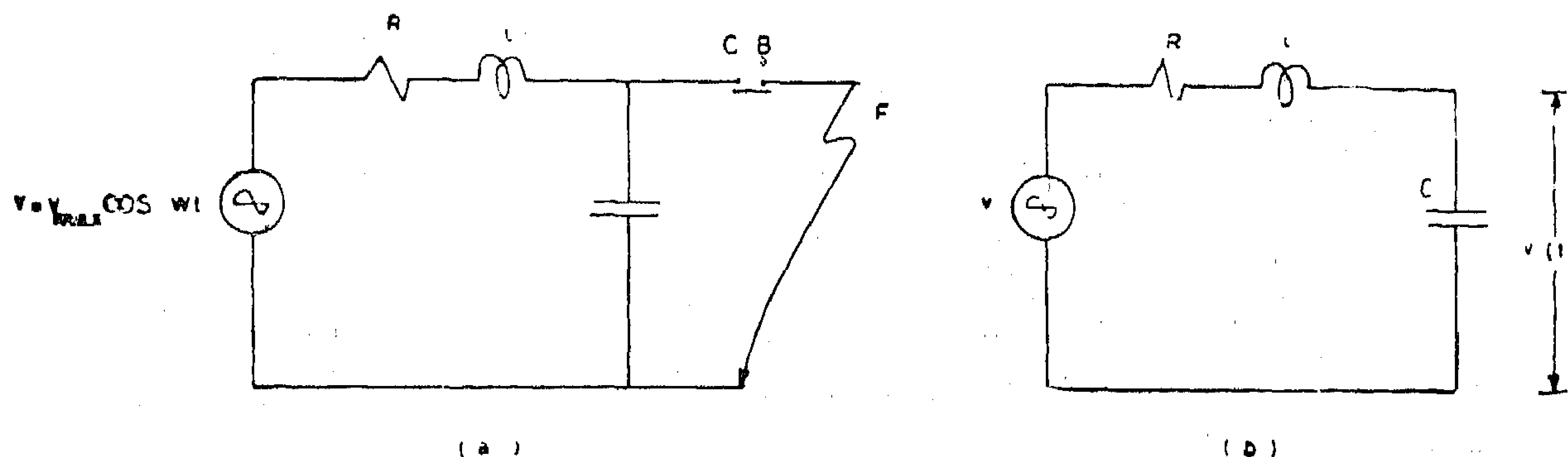


Fig. (1): Simple Equivalent Circuit for Calculation of Restriking Voltage

the transmission line with its double circuit from Aswan to the specified location were represented as lumped elements. Thus, Fig. (1) may represent the network under transient conditions where :

R is total resistance of the transmission line between Aswan High Dam power station and the swithching situation.

L is the series summation of the transmission line leakage inductance and the Aswan-High Dam power station equivalent inductance.

C is the equivalent stray capacitance of the transmission line between Aswan-High Dam power station and the switching situation, lumped at this situation.

The solution of the simplified circuit of Fig. (1) is in the form 8,9

$$V(t) = V_{max} \left[A e^{-at} \cos W_n t + \frac{B}{W_n} \theta^{-at} \sin W_n t - A \cos Wt + \frac{D}{W} \sin Wt \right] \quad (1)$$

where V_{max} is the peak cyclic value of the phase voltage (=408 KV)

a = damping coefficient of oscilations, in sec-1

$= R/2L$ (2)

w_n = natual frequency of the system, in rad/sec.

$$= \sqrt{\frac{1}{LC} - \left(\frac{R}{2L}\right)^2} \quad (3)$$

w = angular frequency of the system, in rad/sec.

$$A = \frac{-(W_n^2 + a^2 - W^2)(W_n^2 + a^2)}{(W_n^2+a^2)W_n^2+a^2-2W^2)+W^2(4a^2+W^2} \quad (4)$$

$$B = \frac{-a(W_n^2 + a^2 - + W^2)(W_n^2 + a^2)}{(W_n^2+a^2)W_n^2+a^2-2W^2)+W^2(4a^2+W^2)} \quad (5)$$

$$\text{and } D = \frac{2aw^2(w_n^2+a^2)}{w_n^2+a^2)(w_n^2+a^2-2w^2)+w^2(4a^2+w^2)} \quad (6)$$

The generated switching off surges9, corresponding to switching off operations at the situations of Cairo, Samalout and Nag-Hammadi are presented on Figs. (2), (3) and (4) respectively.

4. Predicted Performance of Polluted Insulators of the 500 KV Aswan-Cairo Line Under Operating and Surge Voltages :

4.1 Discharge Growth Criteria on Polluted Insulator Surfaces :

The conditions for electrical discharge growth on the surfaces of polluted insulators have been studied by the authors8,9. The relation between the minimum voltage required to maintain conduction along the polluted insulator surface (V_m) and the discharge length (X) has been calculated as :

$$V_m = (1 + n)\left[(1+a) AX\right]^{1/n+1} \cdot r_p \left(\frac{1-(1-bc)X}{n}\right)^{n/n+1} \quad (7)$$

b) With the impulses applied to the polluted insulators after those had been energised by their normal operating a-c voltage3-5.

c) With different types of the contaminant layer wetting methods, such as wet contaminant method, clean fog method and non-uniform pollution method5.

d) With polluted insulator strings of different number of units per string4.

The main achievements obtained from previous investigations may be reported in the following conclusions :

1. The switching-surge flashover voltages of polluted insulators depend on the peak value of the applied voltage as well as the duration of the voltage wave3,5,6.

2. It seems that the dry bands formed on the insulator surface by the pre--applied a-c. wave, may either decrease or increase the flashover voltage under switching surges. This may be ascribed to the suitable width of the formed dry bands. Narrow dry bands would be bridged by partial acrs when triggered by the switching surge, thus enhancing flashover under switching surges3,5,6.

3. The switching surge strength per unit decreases as the number of units per string increases. On these bases, switching surge strength has been the limiting design factor for lines insulation from 345 KV up4.

3. Present Investigation of the Insulation Problem :

3.1 Over-Voltage Surges Generated at EHV Lines :

The above mentioned findings would define two main factors governing the insulator performance. The first is the amplitude of the maximum value of the voltage wave during transient condition. The second is the duration of this transient wave. These two factors depend, in turn, on the network parameters as well as the value of the network voltage at the instant of the switching operation. It may be of special interest to study the system behaviour under the worst possible conditions. Switching off operations at the instant of maximum cyclic value of the system voltage and switching on the line when energised at its maximum voltage are the worst possible operating conditions. Thus, the performance of the polluted line insulation ought to be predicted under such conditions'. This has been carried out for the 500 KV Aswan-Cairo transmission line.

3.2 Switching off Surges on the 500 KV Aswan - Cairo Line

Switching off surges gain their dangerous effects from the restriking voltage wave, travelling along the line section before the circuit breaker towards the power source. This surge wave would be thus super-imposed on the power frequency voltage wave in that section of the line.

Switching on the line, when energised at its maximum cyclic voltage has been known to generate the most severe surges7. Calculation of these swithching on surges on the 500 KV Aswan-Cairo line seems too difficult to calculate at present. Therefore, switching off surges will be considered, for example, to indicate the insulation performance under surges. Calculation will be furtherly completed for the other cases.

The following assumptions were considered in the present investigation to simplify calculations without an appreciable error :

1. The Aswan-High Dam power station with its 12 parallel units were represented by an equivalent inductance.

2. The distributed resistance, leakage industance and stray capacitance of

ON THE INSULATION PROBLEM OF THE 500 KV ASWAN-CAIRO TRANSMISSION LINE

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1. General :

The insulation of high voltage transmission lines has long been one of the main problems confronting transmission engineers. The problem, being too important and complicated, has received the interest of engineers and scientists in various utilities and research laboratories

The performance of outdoor insulators under atmospheric pollution conditions has been the subject of intensive studies. The problem complications arise from the widely different nature of the deposits formed on the surfaces of insulators, depending on the source of pollution,the shape of the insulator, the applied fields as well as the weather conditions1

Further, at the present time, there are many systems of EHV in use, or coming into use, at 500, 735 and even 1000 KV and there is a distinct possibility that still higher voltages will be used in the future. At this order of operating voltages, switching over-voltages can exceed those due to lightning. In this contest, the significant over-voltages are those caused by the energisation of transmission lines, since, given the necessary conditions, over-voltages of as much as four times the phase to neutral voltage of the system are theoretically possible2.

Experience with the Egyptian 500 KV transmission line, connecting the Aswan-High Dam power station to the Cairo 500 KV transformer station, indicates that some flashover events took place on line insulator strings in regions of heavy atmospheric pollution. This called for increasing the insulation level in these regions. Experience also tells about a number of insulation breakdown events which occurred during switching operations. Breakdown occurred at 500 KV circuit breaker polluted insulation as well as at polluted insulator strings. Such experience had been also met with polluted insulator strings of EHV lines in other countries.

Such observations called for the present investigation of the effect of switching surges, on the performance of the polluted insulators of EHV lines, as compared with their performance under their rated voltages. The case of the 500 KV Aswan-Cairo transmission line is of interest in the present paper.

2. Present State of the Insulation Problem Under Surge Conditions :

With EHV coming into use, the insulation problem under surge conditions becomes more significant. However, the number of investigations carried out under these conditions is rather limited, and of experimental nature, than under power freuency. The switching impulse strength of the polluted insulators was measured under the following conditions :

a) With the impulses applied to the polluted insulators with no prior a-c. energisation3-5.

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The nufber of steps is also reduced because as we notice in the second case the required number of steps for a complete solution for a transient period of 1.0 sec. is 50 steps while the number of steps used for the suggested method was 20 steps, i.e. the number of steps is reduced by 60%, this is the case of 0.02 sec. interval. In case of 0.01 sec. interavl the number of steps used were 100 i.e. the number of steps are reduced by 80%.

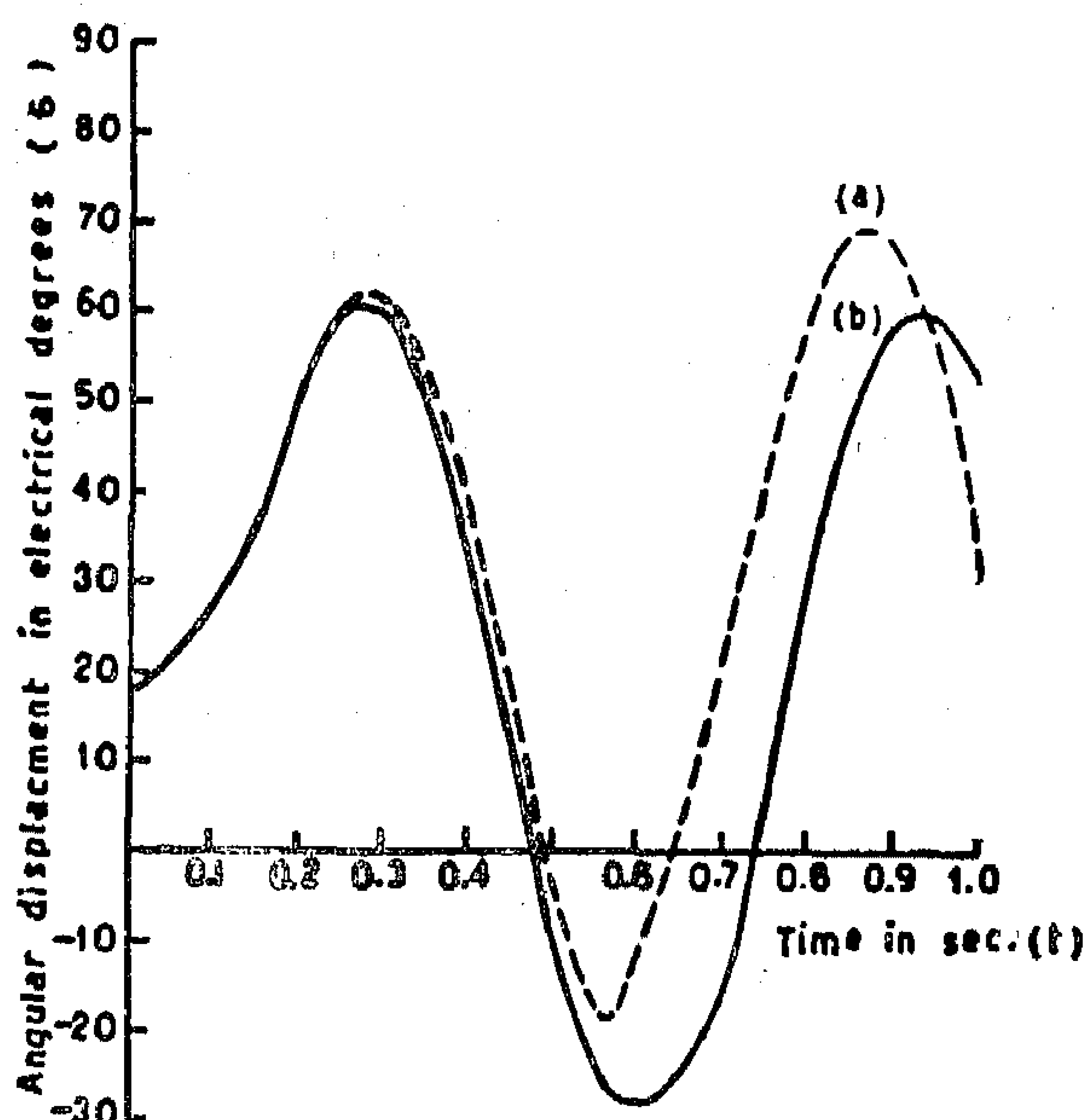


FIG. (6) ANGULAR DISPLACMENT TIME CURVES
——— Suggested method
- - - - Point-by-point method (0.01 sec interval)

CONNCLUSIONS

The suggested method for studying the transient stability of the power system, represented here by a generator connected to an infinite bus through a double circuit transmission line gives a very satisfactory results compared with the usual step-by-step method. The suggested method reduces the number of steps for the solution to about 40%. The reduction in the number of steps does not reduce the accuracy of the solution but the accuracy is raised compared with the usual step by step method. So we can say that the accuracy is improved and the time of solution is reduced.

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APPENDIX I

Notation

The symbols used are as follows :

M is the inertia constant of the machine

6 is the angle between the voltage behind the transient reactance of the machine (E_1) and the infinite bus voltage (E_2)

P_a is the accelerating power

P_s is the mechanical power input

P_o is the electerical power output

E_I the voltage behind the transient reactance of the machine

E_2 the inbnite bus voltage

and at the end of this time, is cleared. The behaviour of the system during a transient period of 1.0 sec. is studied.

Three cases were studied, in the first case the time interval is 0.05 sec., in the second the time nterval is 0.02 sec., and in the third case the time interval is 0.01 sec., and the δ-t curves are plotted using the usual step by step method. The δ -t curves are then plotted using the suggested method and a comparison is made between these curves as shown in Fig. (3), Fig. (5) and Fig. (6). This comparison indicates that the suggested method gives the closest solution to absolute accurate one of the swing equation, so it gives a very high degree of accuracy.

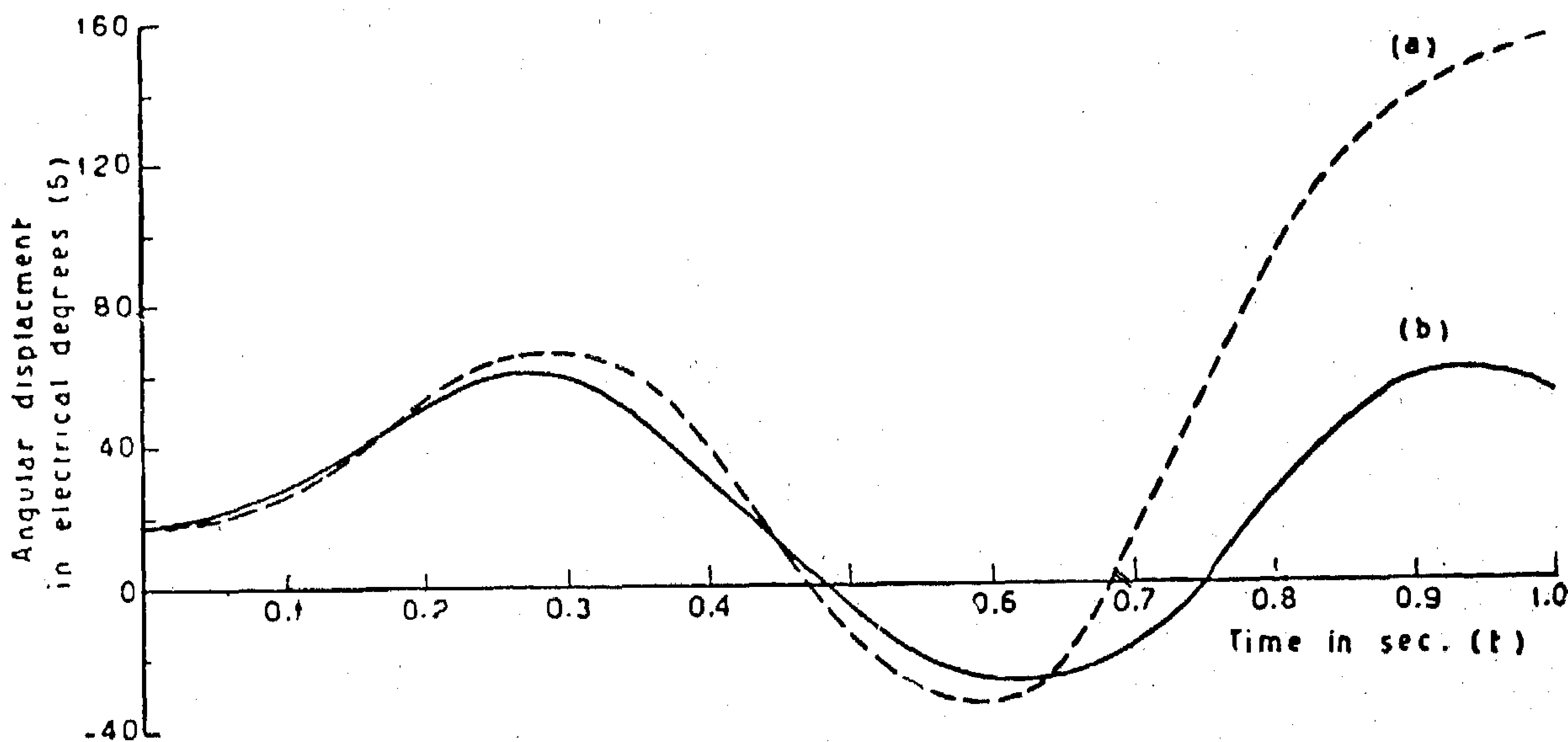


FIG. (3) ANGULAR DISPLACMENT-TIM CURVES

——— Suggested method

- - -+- - Point-by-point method (0.05 sec interval)

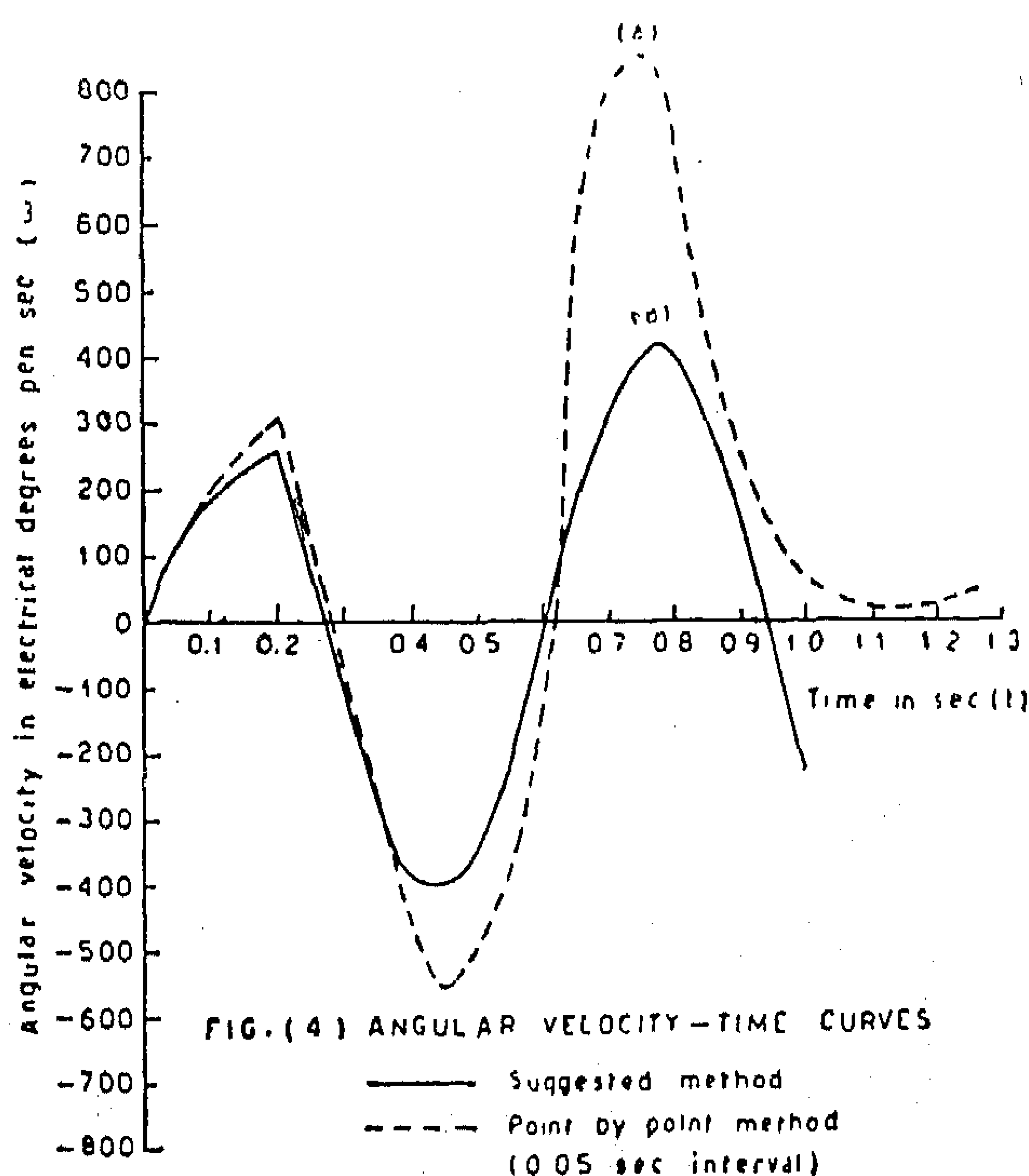


FIG.(4) ANGULAR VELOCITY-TIME CURVES

——— Suggested method

- - - - Point by point method (0.05 sec interval)

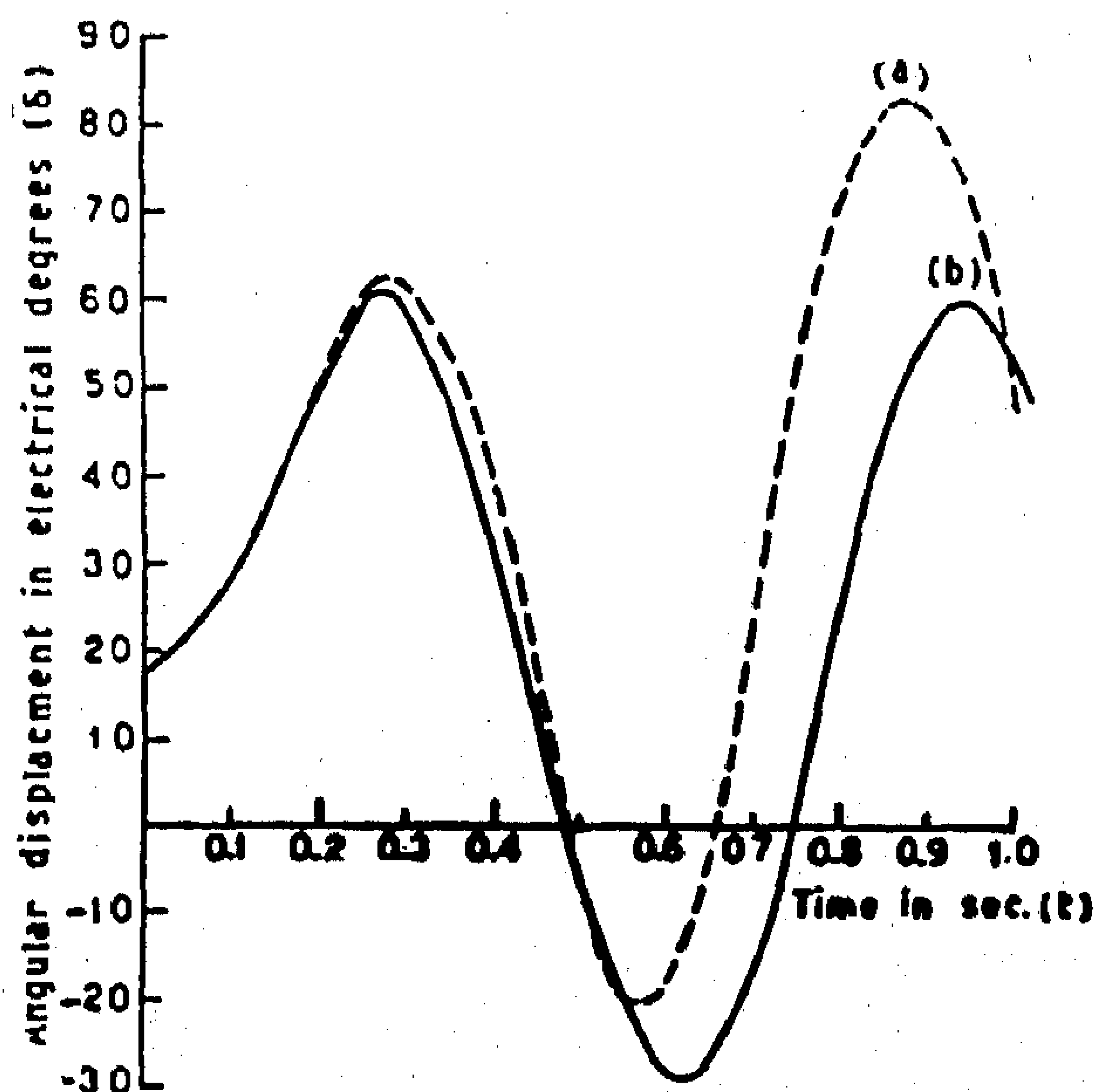


FIG. (5) ANGULAR DISPLACMENT TIME CURVES

——— Suggested method

- - - - Point-by-point methoa (0.02 sec interval)

THE PROCEDURE

The suggested method procedure can be summarized as follows. If we start on a power angle curve (Sin curve) whose maximum is P_m at an angle δ_o and we are proceeding on this curve. the constant G, F and K are to be determined. Then according to the sign of G i.e. if it is positive or negative the angular displacement and the angular velocity can be determined.

Determination of the constants G, F, ϕ o :

The general procedure for calculating the constants G, F and ϕo during the different intervals must carried out as follows . The power system is considered simply as an synchronous machine connected to an infinit bus, then a disturbance occurs and followed by clearing the fault causing this disturbance. So the power system passes through three stages, which can be represented by three power angle curves as shown in Fig. (2).

From the first power angle equation and by knowing the mechanical input power to the machine (P_s), the initial operating angle (δ_{oa}) is determined, and the constants G, F and ϕ_o will be determined according to the initial operating conditions at point (a), Eq. (17). Then substituting for the time in equations (13) or (15) by the appropriate time interval, (the proper time interval is a matter of experience, it is usually in the range 0.05 to 0.2 sec.) the angular displacement is determined. It must not exceet 30 degree or 20 degree. depending on the degree of accuracy required, if it is more than this value the time interval must be decreased to a smaller value and the angle is to be calculated again. Notice that if more than one point is calculated during a certain δ -interval (20—30 degrees) every new value of (δ) must be added to the initial operating angle (δ_{oa}) and not to the proceeding value as in the usual step by step method.

By the same way the angular velocity can be calculated from equations (14) or (16) at the end of every time interval, if the angular velocity curve is to be determined, otherwise it is enough only to calculate it at the end of the whole δ -interval.

So now the initial conditions for a new δ -intetval are known, i.e. (δ ob) and (w_{ob}), see Fig. (2), which are the last values for (δ) and (w') at the end of the proceeding -interval. Then the new constants for the second — -interval i.e. G_b , F_b and ϕ o b are to be calculated and the same procedure is to be followed for calculating the angular displacement and velocity during the second δ -interval.

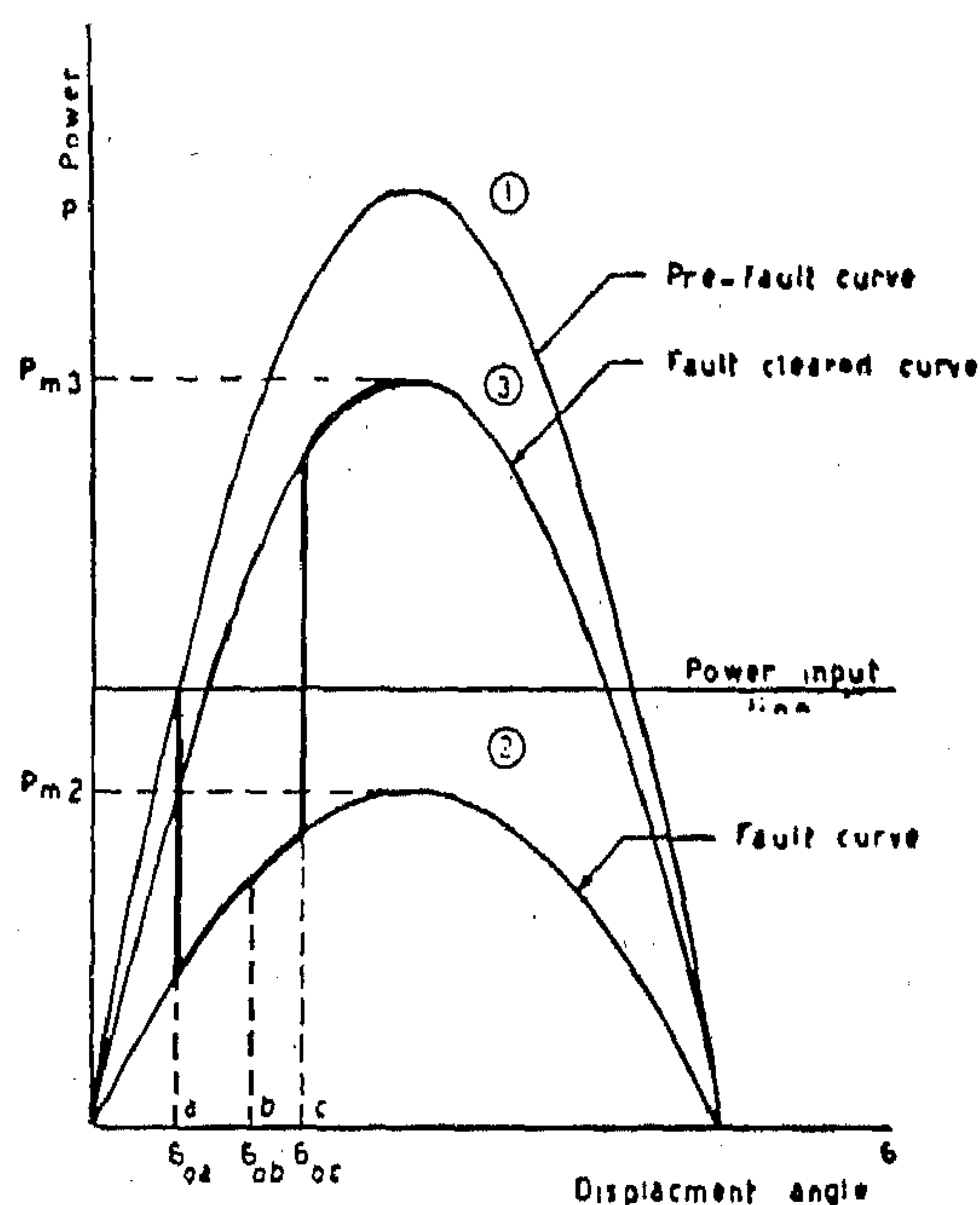


FIG (2) POWER ANGLE CURVES
1. Pre-fault curve
2. Fault curve
3. Fault cleared curve

ILLUSTRATIVE EXAMPLE

The application of the above method will be shown by an illustrative example. Cousider a 8,000 KW generator connected to an infinite bus over a double line circuit, a fault occurs at a point on one of the lines, and it hanges on for 0.2 sec.,

3) The inertia constant of the machine is constant.

4) Resistances are neglected.

5) Damping torques are neglected.

So the swing equation for the case of a synchronous machine connected to an infinite bus bar can be written as follows in equation (1) As shown in Fig. (1) the initial operating point is at the angle δ_0 Shifting the axis from the origin (o. o) to a new point a (O, δ_0), then equation (1) can be modified using equation (2) to give equation (3).

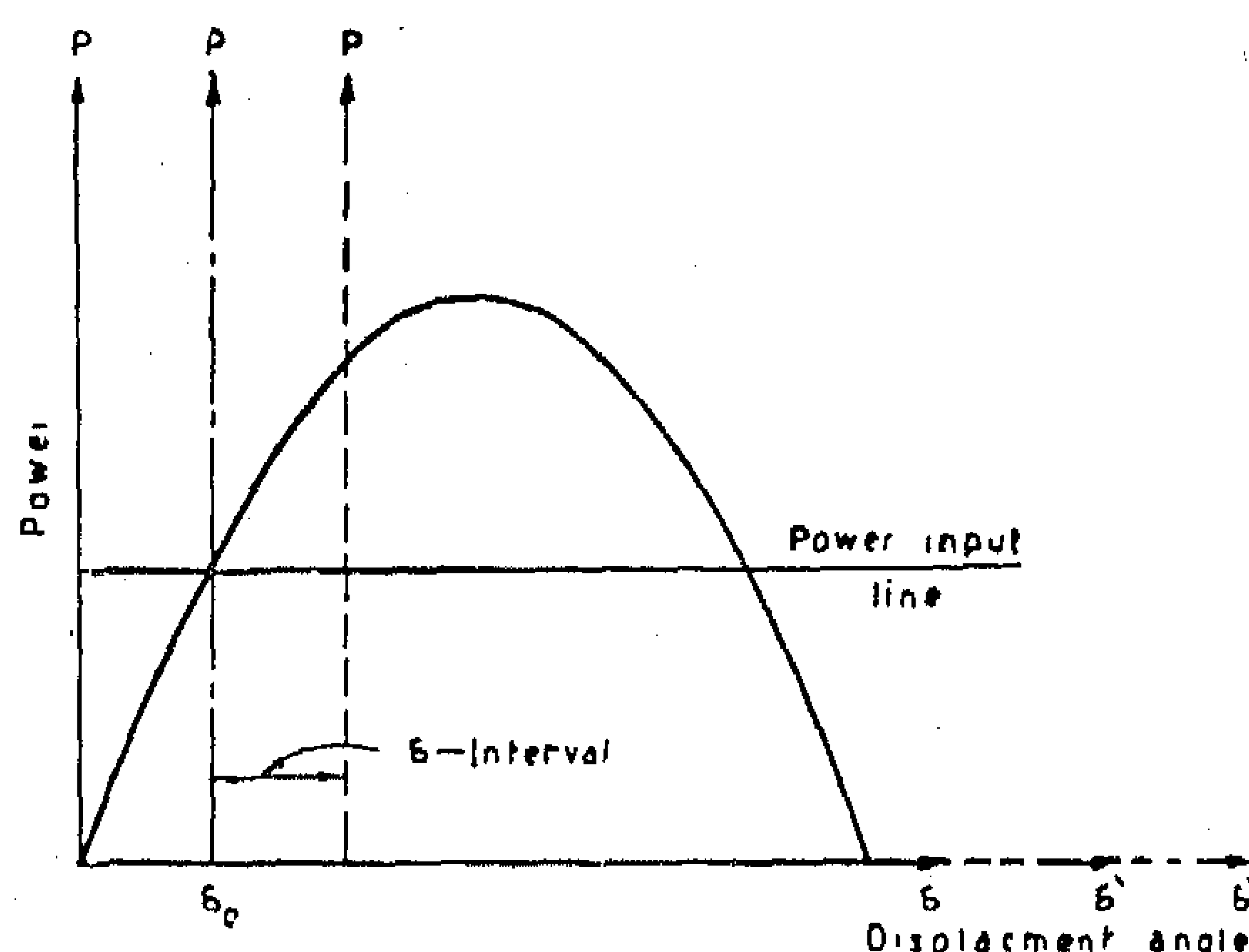


FIG (1) POWER ANGLE CURVE ILLUSTERATING THE SHIFTING OF THE ORIGIN

In the region around δ_0 equation (3) reduces to equation (4) which is a linear differential equation of the second order with constant coefficients. To specify completely the problem in order a unique solution δ (t) can be obtained, two conditions must be specified, the first is the time interval over which the solution is desired and the second is a set of the initial conditions for δ (t) and its derivative. The solution of a differential equation of this class can be divided into two parts, a free response and a forced response. The sum of these two responses constitutes the total solution.

The Free Response :

The characteristic equation of the differential equation (4) describing the system, Eq. (5), has two roots which give the free response, Eq. (6). The unknown coefficients C_1 . C_2 appear in equation (6) can be determined from the initial conditions.

The Forced Response :

The weighting function of the differential equation is given by equation (7). The constants C_3 ant C_4 appear in this equation can be determined from two algebriac equations obtained by satisfying the conditions given by equations (8). The forced response is given by equation (9).

The Total Response :

The total response of the linear constant coefficient differential equation (4) is the sum of the free response, Eq. (6), and the forced response, Eq. (9). Two cases will be considered classified by the nature of the roots of the characteristic equation. The first case is that of real roots and the second case of imaginary roots. General equation will be derived and then the two cases will be studied.

The free response after evaluation of the constants C_1 and C_2 is given by equation (10), and the forced response is given by equation (11) after evaluating the constants C_3 and C_4 . So the total response which is the sum of these two equations is given by equation (12), this equation is the general equation relating the change in the angular displacement to the time and it is valied as far as it does not exeed the range of 20°. The range of validity can be extended to 30° or more but the accuracy will be reduced The form of equation (12) will now be modified according to the nature of the roots of the characteristic equation, i.e. if the constant G is positive or negative.

For the case of real roots equation (12) is reduced to equation (13). The angular speed is given by equation (14). For the case of imaginary roots equation (12) is reduced to equation (15). The angular speed is given by equation (16).

TRANSIENT STABILITY OF POWER SYSTEMS VIA LINEAR TECHNIQUE

By

Dr. MOSTAFA A. EL-SHIBINI*

ABSTRACT :

A method is suggested for studying the transient stability of power systems. This method modifies the usual step-by-step method by linearizing the non linear differential equation describing the system during the transient period. The suggested method reduces the number of steps and so the time of the solution by 60% compared with the usual step-by-step method.

INTRODUCTION

The problem of stability appeared with the appearance of A.C. power systems in the world with it associated synchronous machines. The size of problem increased with the increase interconnection of power systems. The problem was not only how to improve the power system stability but also how to study and analyze the stability problem under the different operating conditions. Many methods have been developed up till now. These methods differ in its field of application and in the required data for solution and the amount of information it gives. For example the point by point method(1)-(3) can be used to examine the stability of any interconnected power system with any number of machines. The swing curves drawn by use of this method give complete informations about the behaviour of the system during the transient period after the occurrence of any disturbance in the power system. While the equal*area criterion(1)-(3) is only applicable for one machine and infinite bus or two machines system. This method gives indication only if the system is stable or not. One of the recent methods used now is he direct method of Lyapunov(4), it requires a partial solution by use of step by step method, but reduces the time of solution.

In this paper we suggest a method which is in its nature a point by point solution, but as the time consumed in the solution especially when using the digital computer is an important factor, this method reduces the time of solution by about 60% and more compared with the usual step by step method. While using Lyapunov function the time reduction is about 30%, with the difficulty of finding the proper function and the determination of the points of singularity. The method suggested can be summarized in that the non linear differential equations describing the system are linearized about the successive operating points on the swing curves.

THEORITICAL CONSIDERATIONS

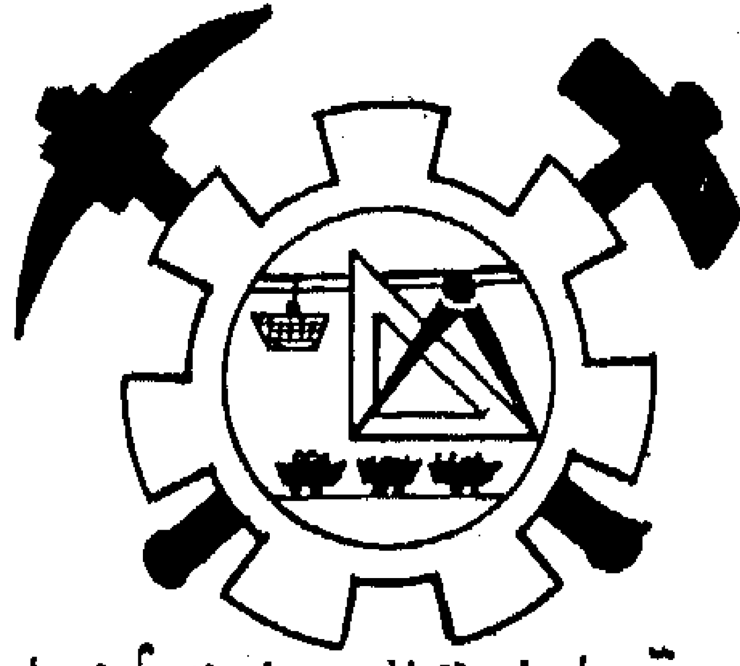
The following assumptions are usually assumed in solving the transient stability problem :

1) The voltage behind the transient reactance is constant.
2) The mechanical power input to the generator is constant.

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الهيئة المصرية العامة للمساحة الجيولوجية والمشروعات التعدينية
(٣ - صلاح سالم بالعباسية - القاهرة)

مكتب التصميمات المصرى للمناجم والمحاجر

نظرا للتطور التكنولوجى الذى حدث فى صناعة التعدين فى العالم وملاحقة لهذا التطور فقد قامت الهيئة بإنشاء مكتب لتصميمات المناجم والمحاجر ، يعتمد أساسا على الفنيين المصريين مع الإستعانة بالخبرة الأجنبية البولندية - حيث يستطيع الفنيون المصريون إكتساب الخبرة اللازمة فى أعمال تصميمات المناجم والمحاجر سواء بممارسة ذلك أثناء عملهم مع الخبراء أو بالتدريب فى الخارج وبذلك يكون لدينا خلال الأعوام القليلة القادمة - وهى مدة تنفيذ عقد إنشاء هذا المكتب مع الجانب البولندى والتى تبلغ ثلاث سنوات - نواة من المهندسين الذين يستطيعون القيام بأعمال التصميم العلمى والتخطيط السليم لإستغلال ثرواتنا التعدينية القومية أحسن إستغلال .

ومن هذا المنطلق فقد حددت إختصاصات مكتب التصميمات بالآتى :

- عمل الدراسات الفنية ووضع خطط المشروعات التعدينية
- عمل التقارير الفنية والإقتصادية .
- عمل التقارير النهائية للمشروعات بما يتضمنه ذلك من التصميمات التفصيلية اللازمة للتنفيذ
- عمل الدراسات الفنية الخاصة بتطوير المناجم الحالية .
- الإشراف على المراحل الأساسية الخاصة بتنفيذ المشروعات .

وعلى ضوء تلك الإختصاصات فقد رؤى أن يكون حجم العمل بهذا المكتب كما يلى :

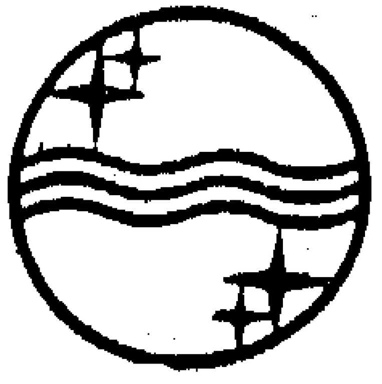
١ تنسيق الإنتاج من خام الفوسفات على مستوى الجمهورية بما فى ذلك بناء المناجم الجديدة (أبو شجيلة بالصحراء الشرقية - المحاميد شرق بوادى النيل) والإعداد لبناء مناجم جديدة ذات إنتاج كثيف (أبو طرطور - السباعية غرب) وإعادة بناء المناجم الحالية بقطاعى سفاجا والقصير وذلك تمهيدا لتصعيد مستوى الجمهورية بين الدول المنتجة لهذا الخام إلى مركز مرتفع وحتى يتسنى بعد ذلك تصدير الخبرة المصرية ولو على الأقل للدول العربية والإفريقية .

٢ بدء تشغيل أو الإعداد لتشغيل الإنتاج من بعض المعادن المتوفرة بالجمهورية ولاسيما للإحتياطيات التى لا تسمح بقيام شركات مستقلة وذلك بمستوى نصف صناعى مثل خامات القصدير والزنك والرصاص والنحاس ، حتى يكون ذلك بمثابة إكتساب خبرة عملية على وسائل التشغيل وحتى يجد الجيل الجديد من المهندسين مجالا للتدريب بالإضافة إلى تدبير جزء لا بأس به من إحتياجات الدولة من هذه الخامات .

٣ إجراء التصميمات المطلوبة لكافة الأعمال التعدينية اللازمة لمناجم ومحاجر الجمهورية .

ويقوم بالعمل بمكتب التصميمات الآن مجموعة من الخبراء البولنديين المتخصصين فى مجالات التعدين المختلفة يصل عددهم إلى ١٤ خبيرا ، ويقوم بالعمل معهم مجموعة كبيرة من المهندسين والفنيين المصريين .

قمة الصناعة العربية المتطورة . تقدمها فيليبس



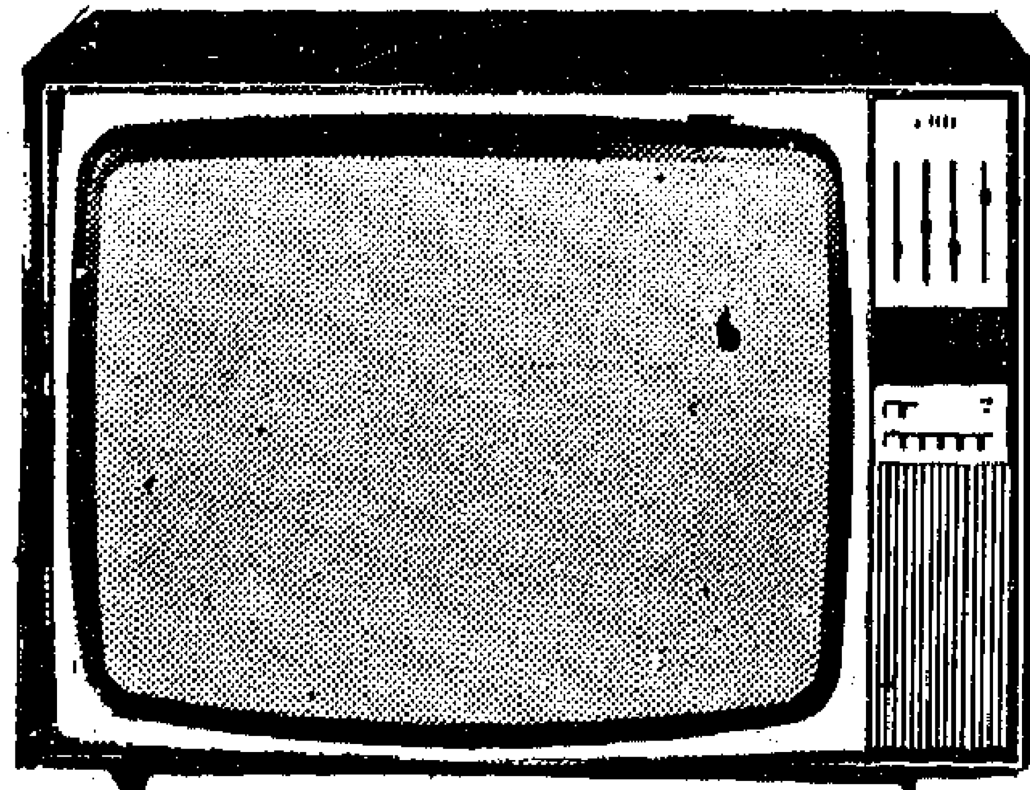
شركة النصر للأجهزة الكهربائية والألكترونية

« فيليبس »

إحدى شركات المؤسسة المصرية العامة للصناعات الهندسية والكهربائية والالكترونية

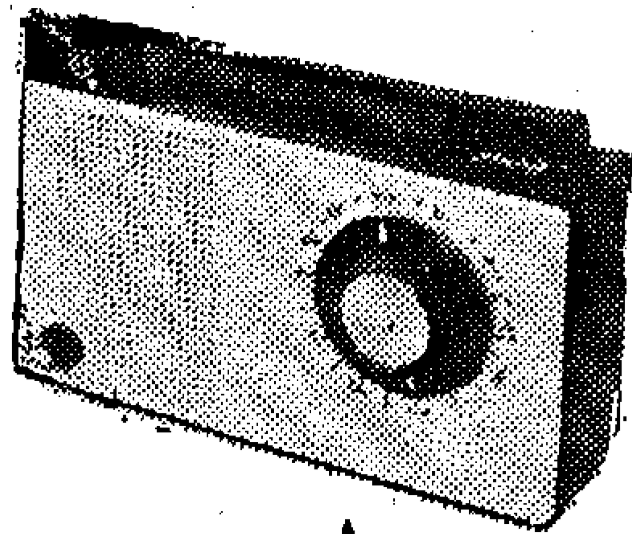
EL-NASR ELECTRICAL & ELECTRONIC APPARATUS Co. S.A.A,

PHILIPS



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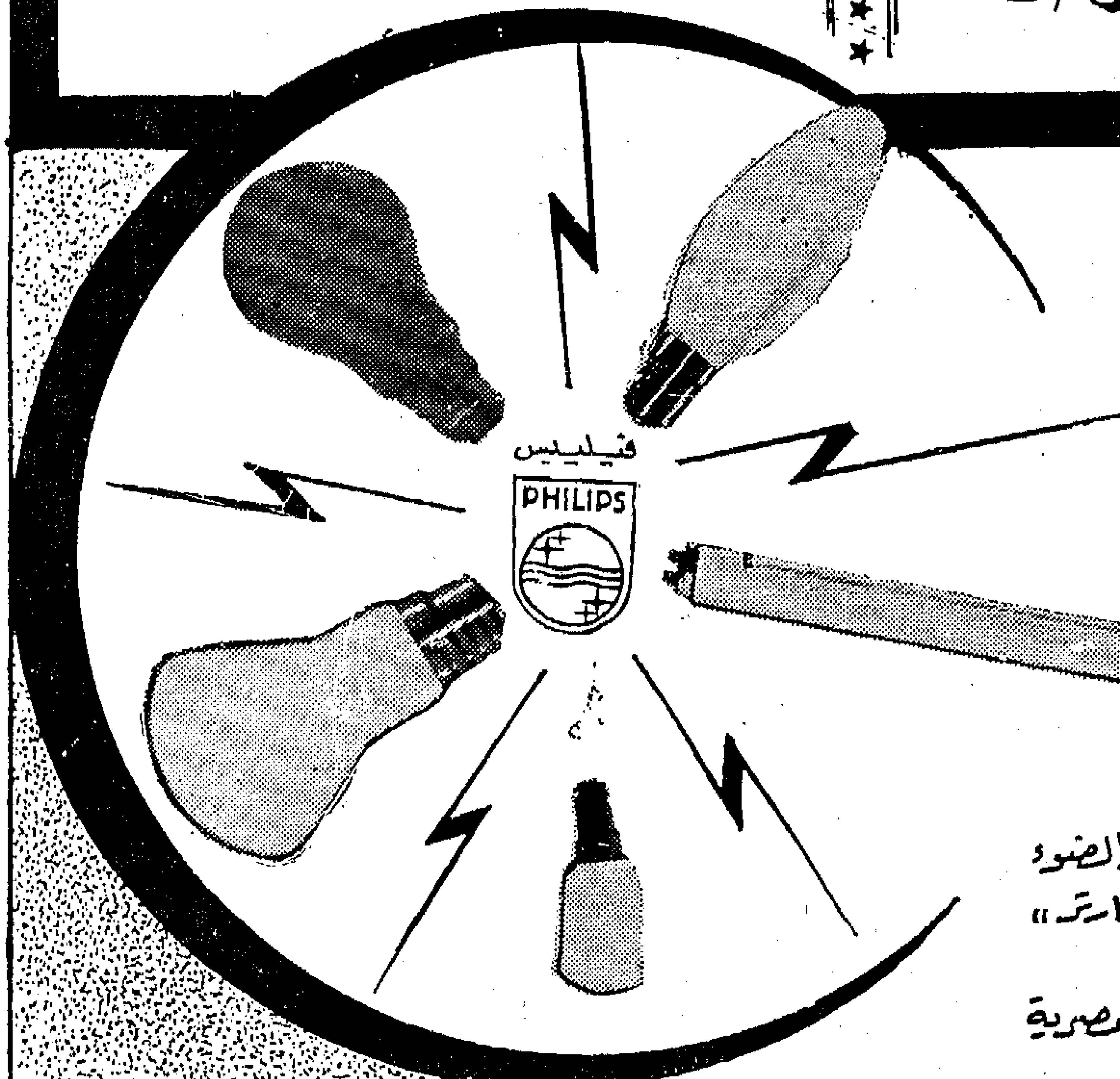
فيليبس ٢٤ بوصة



راديو

فيليبس

ترانزستور شنطة



كبرى شركات

إنتاج المصابيح

الكهربائية

في الشرق الأوسط

مجموعة مختلفة الأشكال

من المصابيح الكهربائية

العادية والفلورسنت والزئبقية والضوء

المختلط وبادئ الإنارة « ستارتر »

للمبات الفلورسنت

تفي بكافة أغراض الإضاءة العصرية

المكاتب والمعارض : ٢٦ شارع عدلي بالقاهرة - كيس بريد القاهرة ت ٧٤٦٩٣-٤٩٧٤٨

فرع الإسكندرية : ٩ شارع سيزوستريس تليفون : ٢٥٧٦٠

مركز الخدمة : ٣١١ شارع شبرا بالقاهرة تليفون : ٩٤٤٥٩٩

العنوان التلغرافي « فيلور » القاهرة

شركة وادي كوم أمبو

احدى شركات المؤسسة المصرية العامة لاستصلاح الأراضى

الإدارات والورش والمخازن : دار السلام - قسم مصر القديمة «آخر خط اتوبيس ٩٥-٩٦-٢»

تليفون : ٨٤٥٠٦٦ - ٨٤٥٦٩٠ - ٨٤٥٧٧٥

تقوم بدورها فى تنفيذ برامج الخطة

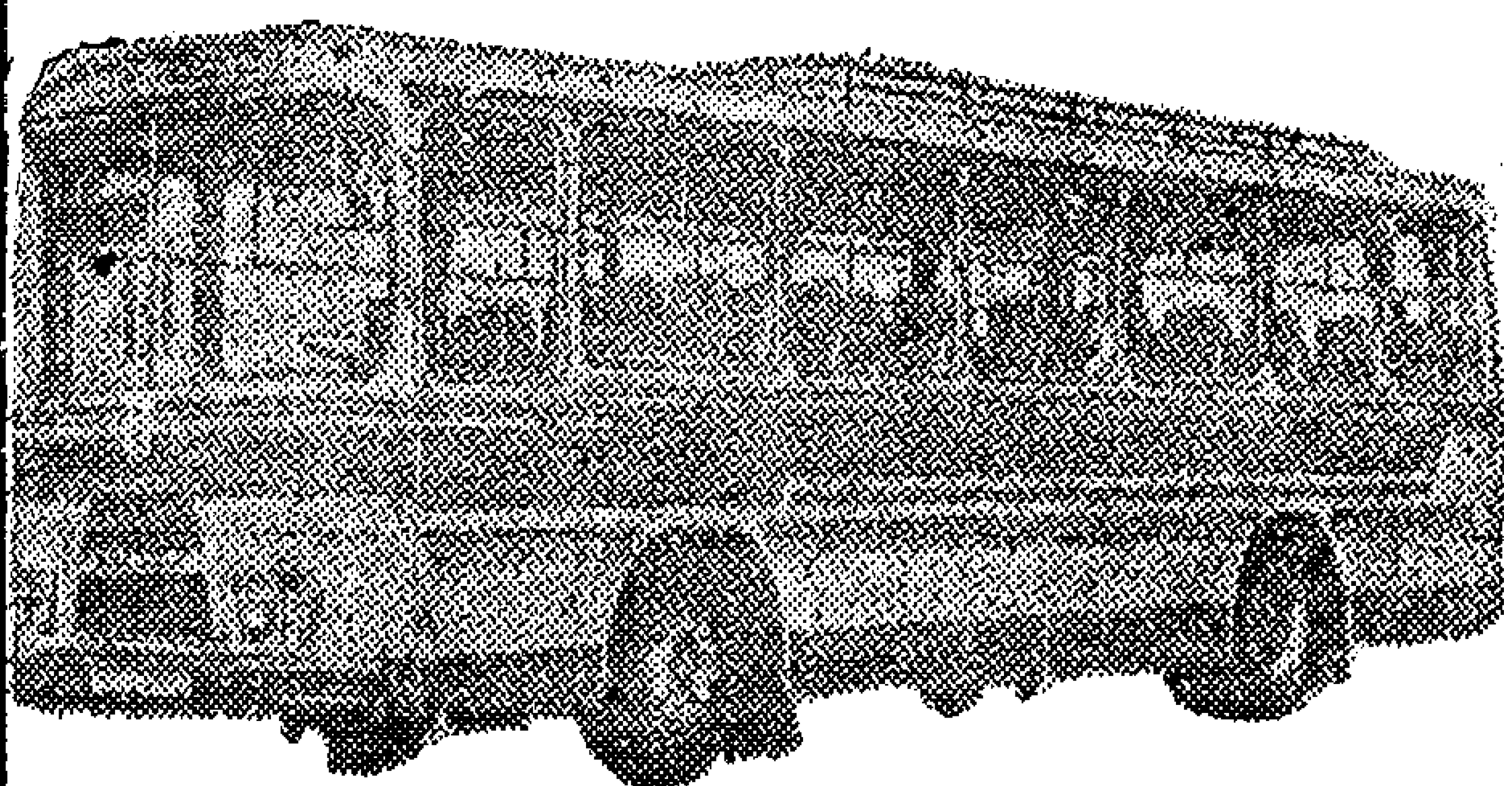
فأتمت استصلاح حوالى ١٢٠٫٠٠٠ فدان بمناطق كوم أمبو - إدفو - إسنا - سوهاج - مديرية التحرير مريوط - بالإضافة الى اعمال الصرف المغطى ، وإنشاء محطات الرى والصرف الكبرى فى جميع أنحاء الجمهورية ... وتعمل حاليًا فى تنفيذ تطوير الملاحة فى قناة السويس مع إزالة الساتر الترابى .. وأنقاض خط بارليف

تمتلك الشركة ٢٥٠ وحدة معدة ميكانيكية ثقيلة لحفر ونقل الأتربة عدا سيارات النقل والمعدات الأخرى .. وتقوم بجانب عمليات الاستصلاح بعمليات مقاولات أعمال الرى الكبرى فى كافة أنحاء الجمهورية

شركة النيل العامة لأوتوبيس وسط الدلتا

احدى شركات المؤسسة المصرية العامة للنقل البرى للركاب بالأقاليم

تسهم بكامل إمكانياتها فى القيام بأعمال النقل العام للركاب بالأوتوبيس ، فى خطوط منتظمة أو فى عمليات خاصة بالرحلات والسياحة وغيرها



قامت الشركة بتسيير أحدث سياراتها على شبكة خطوطها التى تربط محافظات :

المنوفية • الغربية • كفر الشيخ

وتربط بين هذه المحافظات :

القاهرة • الإسكندرية • القليوبية

الشرقية • الدقهلية

وقد حققت نجاحًا ملموسًا فى تقديم خدماتها لنحو ٤٠ مليون راكب تنقلهم بسياراتها الحديثة سنويًا

الإدارة العامة : ١٣٤٣ شارع كورنيش النيل - الساحل

تليفون : ٩٤٦٣٢٤ - ٩٤٨٧٦٤ القاهرة

الخامات الأولية
والصناعات الكيميائية

جمعية مهندسى المناجم والبترول
والفلزات
جمعية المهندسين الكيميائيين

tors and operating conditions the same in both cases.

The conversion is controlled at the initial stages by diffusion o f $(NH_4)_2 CO_3$ through a laminar liquid layer surrounding the particles whereas it was controlled at later stages by diffusion through an ash layer of $CaCO_3$ resulting from the conversion. The rate of conversion per unit geometric surface area of particles in the two ranges are given by the equations.

(i) Initial conversion rate range

$$\frac{dx}{S d\theta} = k_1$$

$$\frac{dx}{S d\theta} = K (1 - x)^3$$

(ii) Second conversion rate range

where k K are coefficients the value of which depend upon slurry concentration, static slurry height, gas flow rate, and temp. of slurry during fluidization.

Optimum condition are **predicted** from the investigations within the specified ranges as :

- Particle Size :—270 + 325 mesh
- Slurry Concn : 5 wt. % Gypsum
- Static Slurry Height : over 3 cms.
- CO_2 Flow Rate (F-factor) = 1.6

$$\left(\frac{cm}{sec.} \cdot \sqrt{\frac{gm}{cm^3}}\right)$$

References :

(1) Ganz, II.S.N., Leibovish, S.B. and Gorbman S.I. (Chem. — Technol. Inst., Dmepropetrousk) Zhur. Priklad. Khm, 32, 975 — 8 (1959).

(2) Andrew. S.P.S. Chem. Eng. Science, 3,279 (1954).

(3) Levenspiel, Chemical Reaction Engineering p. 332 — 357.

A comparison was performed with Levenspiel models (3) of rate controlling steps in heterogeneous system kinetics by plotting (1 — x) versus $\frac{\Theta}{\gamma}$ which represents fractional conversion time as shown in Fig. (10). Comparing with the relevant diagrams of Levenspiel it was verified that the conversion is ash layer diffusion controlled after the initial constant conversion rate.

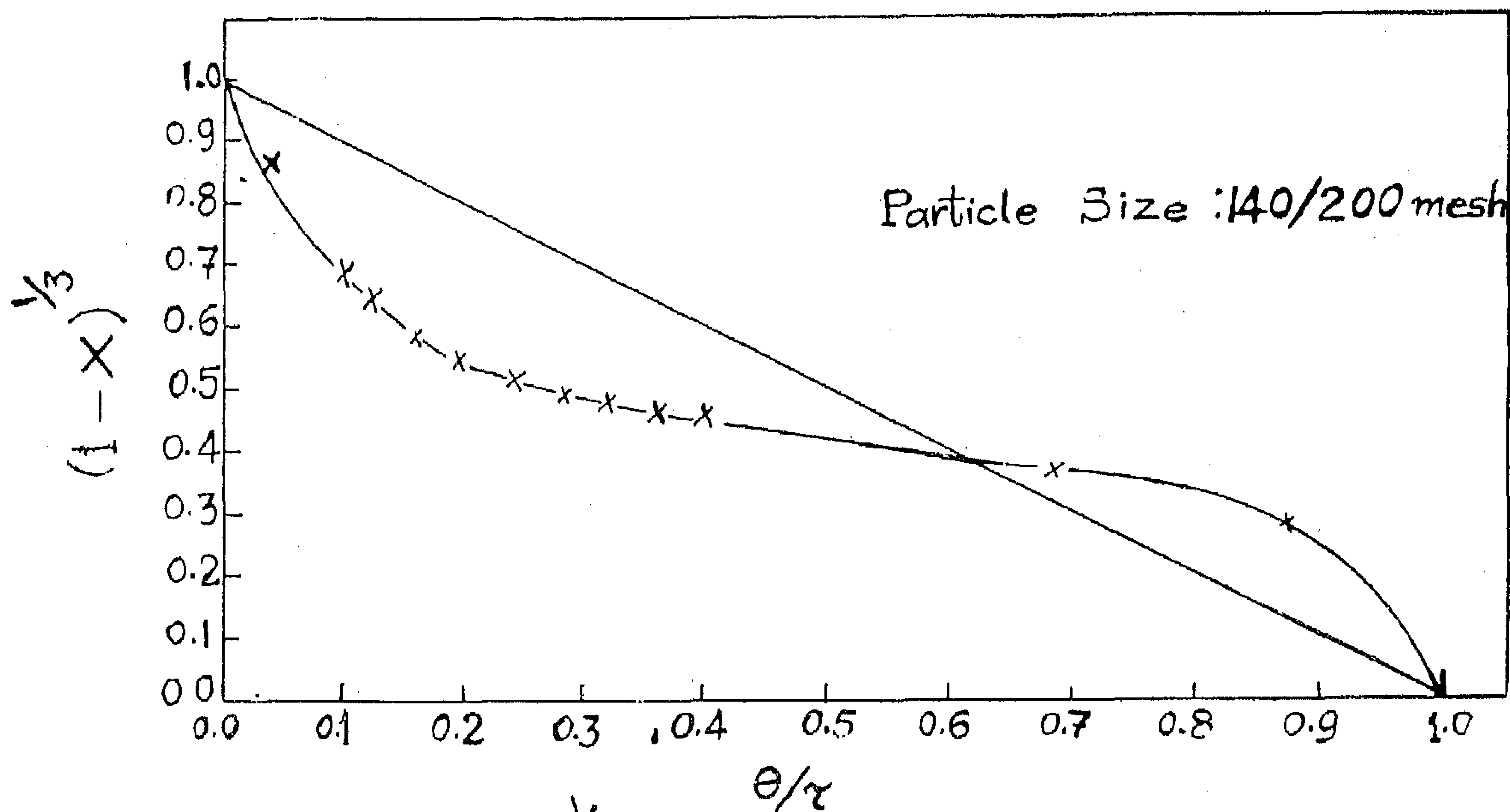


Fig.(10) $(1-X)^{1/3}$ vs. Fractional Conversion Time

(6) Comparison Of The Results Of This Work With Ganz. Work Using Mechanically Agitated Mixers :

Ganz et al(1) reported investigations on the conversion of $CaSO_4 . 2H_2O$ into $(NH_4)_2 SO_4$ in a mechanical mixer used for agitating a mixture of gypsum slurry, CO_2 and NH_3 gases. He reported a decrease in the percentage conversion as the gypsum concentration in the slurry was increased from 6.4 to 12.6 wt% which is quite in good agreement with the results of this work. The maximum percentage conversion reported in his work was 94% whereas it equalled 96% in this work using fine particle sizes.

7 — CONCLUSION

The conversion of $CaSO_4$ into $(NH_4)_2 SO_4$ can be readily affected at ammoniated gypsum slurries, fluidized by CO_2 gas. A percentage conversion as high as 96% was achieved using a particle size of 270 + 325 mesh with gypsum concentration in the slurry of 5 wt%, static height of 3.16 cms and CO_2 flow rate corresponding to F-factor of 1.4 (cm./sec). $\sqrt{gm/cm3}$ The conversion rate per unit geometric surface area of the particles is the same for any particle size provided other factors and operating conditions are the same. Slurry concentrations of 5 wt. % gypsum favour higher conversion than in case of higher concentrations; also increasing the static height from 1.58 cms to 3.16 cms gave a considerable rise in the percentage conversion keeping other fac-

$$E = \frac{C_\theta - C_\infty}{C_o - C_\infty} = \frac{8}{\pi^2} \cdot e^{-\frac{\pi^2}{4} \cdot \frac{D\theta}{a^2}} \quad \ldots\ldots (9)$$

$$\text{(or) } E = \ln \frac{8}{\pi^2} - \frac{\pi^2}{4} \cdot \frac{D\theta}{a^2} \quad \ldots\ldots (10)$$

In examining the possibility of applying equation (9) for the analysis of the results of this work in the second conversion range, c was taken to represent the $(NH_4)_2CO_3$ concentration and an alternative measure for E was derived as follows,

$C_o = [K(1-o) + K'] : K$

K = Stoichiometric proportionality constant

K′ = Constant to account for excess $(NO)_2CO_3$ over the stoichiometric requirement

K = Slurry dilution coefficient

$C_\infty = K' : K$

$C\theta\ [K(1-x) + K'] . K$

and we get,

$$E = \frac{[k(1-x) + k' - k']K}{[k + k' - k']K} = (1-x) \quad \ldots\ldots (11)$$

Therefore Eq. (9) can be put in the following form,

$$1 - X = \frac{8}{\pi^2} \cdot e^{-\frac{\pi^2}{4} \cdot \frac{D\theta}{a^2}}$$

which on differentiation with respect to Θ gives

$$-\frac{d(1-x)}{d\theta} = \left(\frac{\pi}{2}\right)^2 \cdot \frac{D}{a^2}\ (1-x) \quad \ldots\ldots (12)$$

The diffusion length through the solid, a, is proportional to the thickness of the ash layer and its tortuosity. It is assumed that the tortuosity in the ash $CaCO_3$ layer is the same throughout the diffusion path which can then be considered proportional to the depth of the ash layer. The diffusion lenth, a, is inversely proportional to (1 — x) so that we get

$a \propto \frac{1}{1-x}$ for a certain particle size. Substituting $a = \frac{K}{1-X}$ in Eq. (12) we get for constant average diffusion coefficient D.

$$\frac{dx}{d\theta} = K\ (1-x)^3 \quad \ldots\ldots (13)$$

This means that $dx/d\Theta$ is an exponential function in (1 — x) with a power of 3. This is actually the case in the falling rate range shown in Figure (7).

The conversion rate per unit geometric surface area of particles $dx/sd\theta$ is plotted versus (1 — x) in Figure (9) from which the following rate expressions are derived,

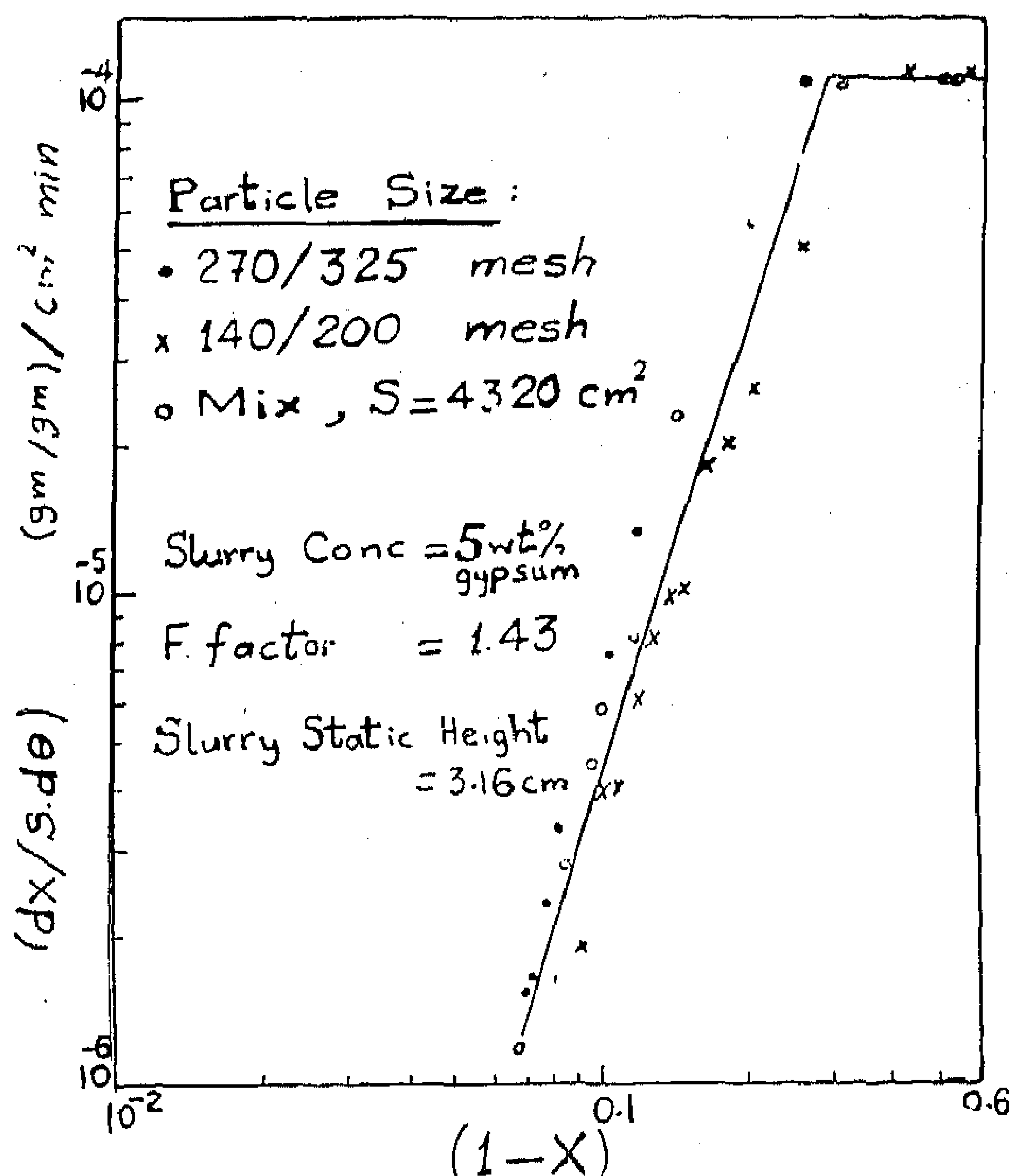


Fig. 9. Conversion Rate VS — Residual Fraction $CaSO_4$

$$\frac{dx}{Sd\theta} = 1.125 \times 10^{-4} \quad (gm/gm)/cm^2 \cdot min \ldots (14)$$

(i) For values of $(1 - x) \geq 0.275$ we get,

(ii) For values f $(1 - x) \leq 0.275$ we get,

$$\frac{dx}{Sd\theta} = 4 \times 10^{-3}\ (1-x)^3 \quad (gm/gm)/cm^2\ min. \ldots (15)$$

$(NH_4)_2 CO_3$ in appreciable amounts at low percentage conversions indicating that steps (i) and (ii) are not rate controlling of the conversion. The existence of a constant conversion rate at the initial stages is a good indication that the conversion is not chemical reaction controlled throughout the whole period of fluidization. In the constant conversion rate range the diffusion of $(NH_4)_2 CO_3$ through the laminar liquid film surrounding the particles is controlling and in the falling conversion rate range the diffusional resistance is increased due to the build up of $CaCO_3$ ash layer on the surface of the solid particles.

(5) Mathematical Models And Its Application To Describe The Conversion Rate Ranges :

The rate of diffusion of $(NH_4)_2 CO_3$ to the reacting $CaSO_4$ is relatively fast at the start and it slows down gradually as the resistance to diffusion increases with the build up of an ash layer of $CaCO_3$. If the chemical reaction is the controlling step it should be slower than the diffusion rate. The fastest diffusion rate takes place at the start of conversion and it is clear from the previously presented figures that the conversion rate is constant in this case and independent of the fractional amount of remaining reactant. This means that the conversion rate is not chemical reaction controlled from the start. This was verified by the impossibility of correlating the experimental data in terms of equation (3) or its integrated from equation (4).

$$\frac{d(1-x)}{S\,d\theta} = -k\,(1-x)^n \quad \text{.........(3)}$$

$$\theta = \frac{1}{(1-n)k} \cdot \frac{r}{S}\left[1-(1-x)^{1-n}\right] \quad \text{...... (4)}$$

From this it is deduced that the conversion is controlled by diffusion throughout the whole period. At the start, the conversion rate is controlled by diffusion of $(NH_4)_2 CO_3$ through a laminar liquid film surrounding the particle and we have,

Rate of mass transfer by diffusion = $D \frac{\partial CA}{\partial z}$ $(NH_4)_2 CO_3$ diffuses towards the reacting solid and the concentration gradient across the diffusion liquid film decreases with time whereas the diffusion coefficient D increases by the same rate due to the proportional decrease in the concentration of dissolved solutes in same film at the start. This gives a constant diffusion rate and hence a constant rate of conversion as represented by the equation,

$$\frac{dx}{S\,d\theta} = K \quad \text{---------(5)}$$

This gives on integration,

$$X = SK_\theta \qquad (6)$$

Equation (6) represents a straight line passing through the origin and having a slope depending on the specific surface of the particles. This explains the constant conversion rates shown in Figures (2,3,4,5,7,8). As the reaction proceeds the diffusional resistance of $CaCO_3$ ash layer becomes more controlling and we get a case of unsteady state diffusion through a solid. Applying differential mass balance we get in this case.

$$\frac{\partial c}{\partial \theta} = D\,\frac{\partial^2 c}{\partial z^2} \quad \text{---------(7)}$$

The solution of the above equation gives the series,

$$E = \frac{C_o - C_{o\theta}}{C_o - C_\infty} = \frac{8}{\pi^2}\left[e^{-\frac{\pi^2}{4}\frac{D\theta}{a^2}} + \frac{1}{9}e^{-9\frac{\pi^2}{4}\frac{D\theta}{a^2}} + \cdots\right] \text{...(8)}$$

In the above equation (8), θ represents the time of diffusion through the solid, D is the average duffusion cofficient, and a is the length of the diffusion path. Considering only the largest term on the R.H.S. of Eq. (8) we get,

initial stages and then it decreases continuously. Figure (8) shows a plot of the conversion rate per unit surface area of particles, versus the residual fraction unreacted Ca SO_4. A common curve could be drawn for the different sized fractions of particles which may be divided into two distinct ranges :

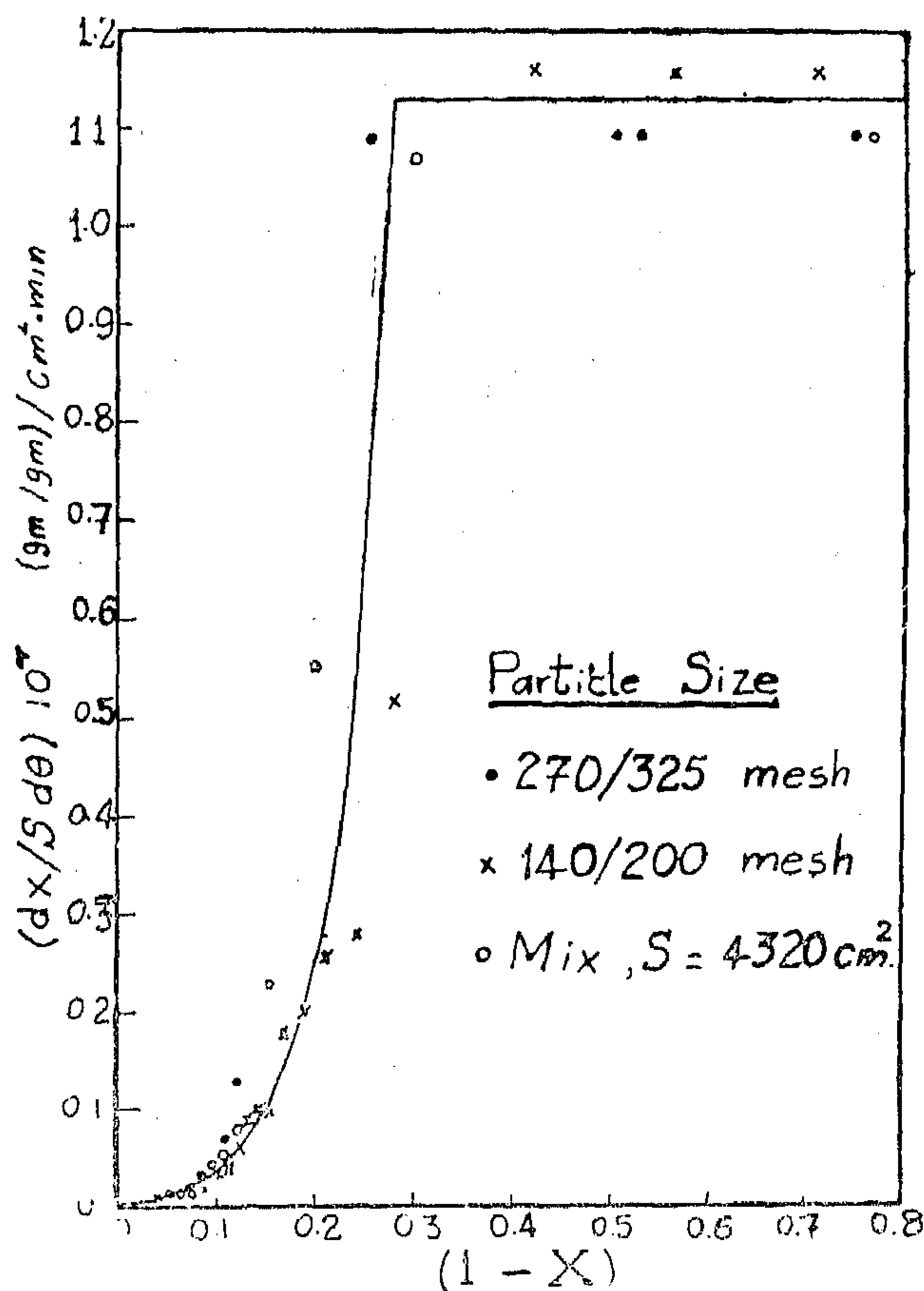


Fig. 8. Conversion Rate VS. Residual Fration Ca SO

(a) For values of $(1 - x) > 0.275$ we get a constant conversion rate range.

(b) For values of $(1 - x) < 0.275$ we get a falling conversion rate range.

(4. 2) Sequence Of Steps Affecting The Conversion Of $CaSO_4$ Into $(NH_4)_2 SO_4$ From Ammoniated Gypsum Slurry Through Fluidization With CO_2 gas.

The conversion of $CaSO_4$ into $(NH_4)_2 SO_4$ takes place through a series of steps which occur in the following sequence :

(i) Absorption of Co_2 gas in the ammoniated slurry.

(ii) Interaction between CO_2 and NH_4OH in aqueous Solution to give $(NH_4)_2 CO_3$

$$4NH_4OH+2CO_2=2(NH_4)_2CO_3+2H_2O$$

(iii) Diffusion of $(NH_4)_2CO_3$ in the aqueous phase to the reaction boundary at the solid gypsum particles interface. The diffusion shall have to take place through a laminar liquid film surrounding the particles at the start of interaction and it will proceed as time passes through an ash layer of resultant Ca CO_3

(iv) Interaction of $(NH_4)_2 CO_3$ reaching Ca SO_4 to give $(NH_4)_2 SO_4$

$$(NH_4)_2CO_3+Ca\ So_4=(NH_4)_2So_4+Ca\ Co_3$$

The Ca CO_3 being insoluble in water remains at the reaction boundary forming an ash layer that increases in thickness with further interaction of remaining Ca SO_4. The produced $(NH_4)_2 SO_4$ shall have to diffuse from the reaction boundary through a laminar liquid film surrounding the particles at the start of interaction and through an additional ash layer of Ca CO_3 as the reaction proceeds.

As the above steps take place in series it is evident that the slowest step will be the one controlling the rate of conversion. Andrew(2) in an investigation on CO_2 absorption by partially carbonated ammonia solutions reported that the rate of CO_2 absorption is controlled by the reaction between CO_2 and ammonia. Thus the the first step is excluded from being a rate controlling step. Again it has been revealed by chemical analysis that the filtered slurry after fluidization contained

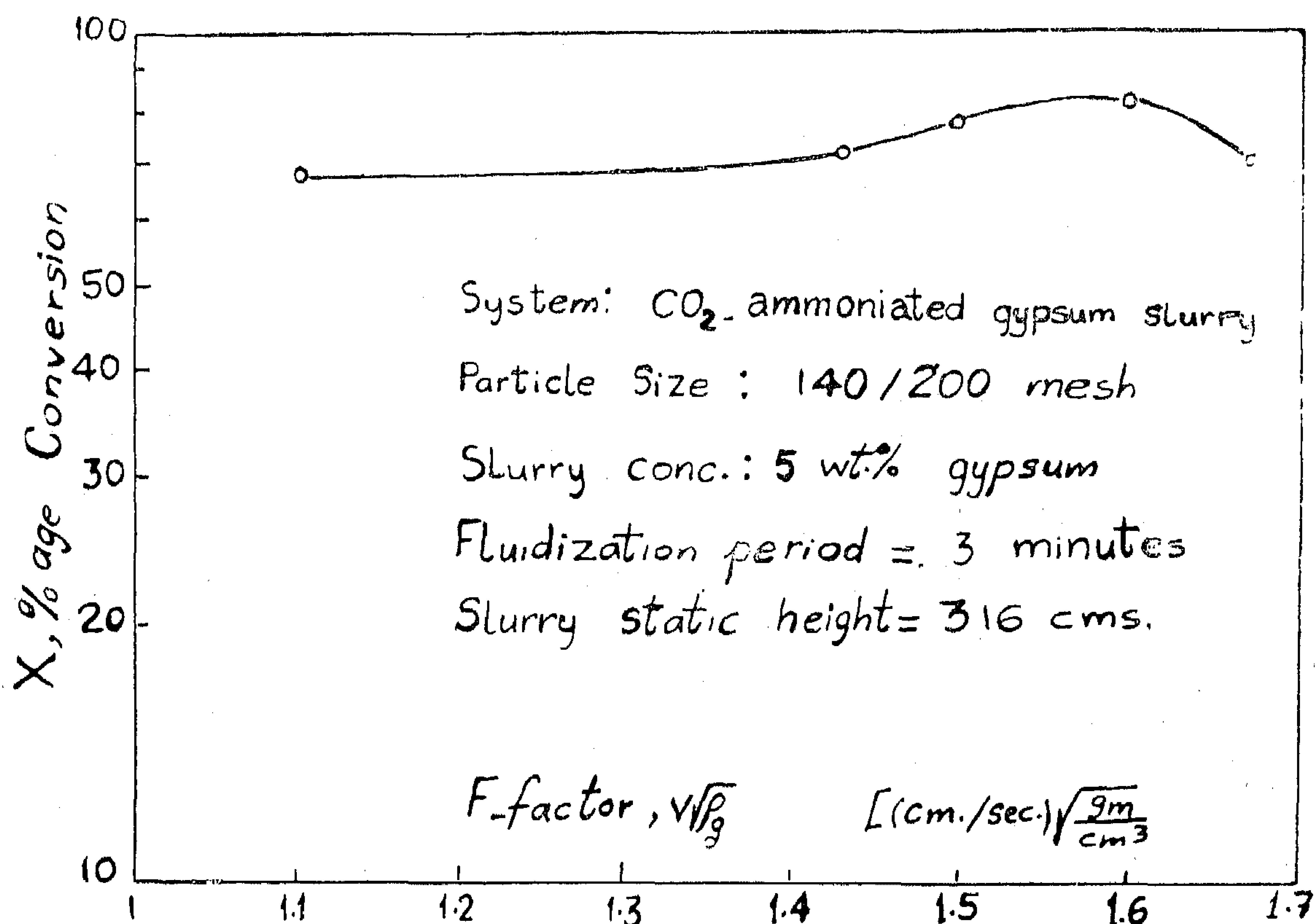


Fig. 6. Effect of gas rate on % conversion

4 — ANALYSIS AND CORRELATION OF EXPERIMENTAL RESULTS

The analysis of the results and its correlation is presented below in the following items.

(4. 1) Conversion Rate Per Unit Surface Area Of Particles :

Graphical differentiation was applied to determine the instantaneous conversion rates from figure (3) for the different particle sizes. This gives the conversion rate as mass fraction $Ca\ SO_4$ converted into $(NH_4)_2\ So_4$ per unit time, $\frac{dx}{d\theta}$ Dividing this rate by the surface area of the particles in the used slurry we get the rate per unit surface of particles. Figure (7) shows the conversion rate versus the residual fraction unreacted $Ca\ SO_4$ (1—x), from which it is observed that the conversion rate, $\frac{dx}{d\theta}$ is constant during the

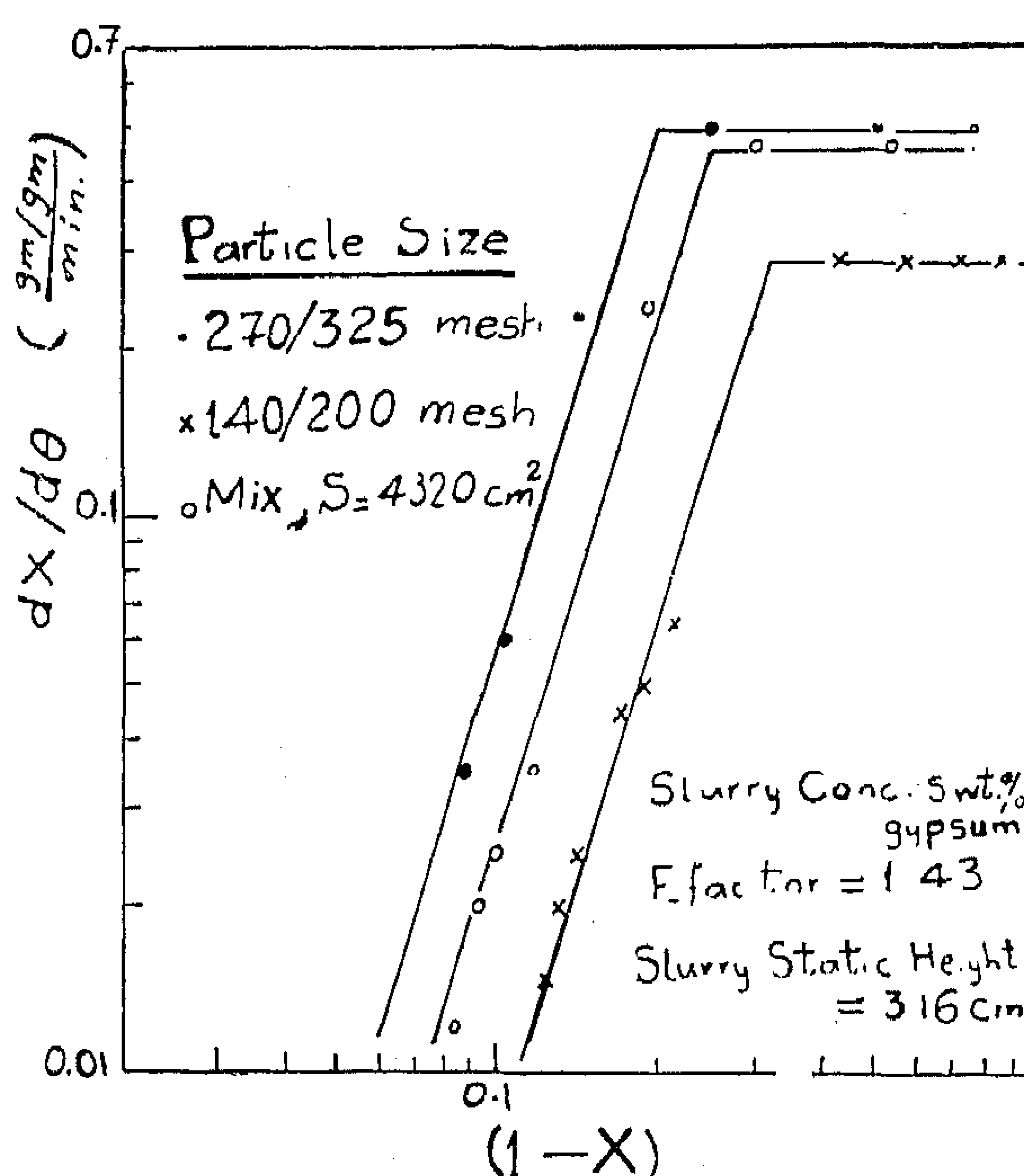


Fig. 7. Effect of Particle Size on Conversion Rate

being a result of extended surface of contact between the solid and liquid phases as the froth height is greater with dilute slurries. This means that 5 wt% gypsum concentraion in the slurry is much more favourable than higher concentrations.

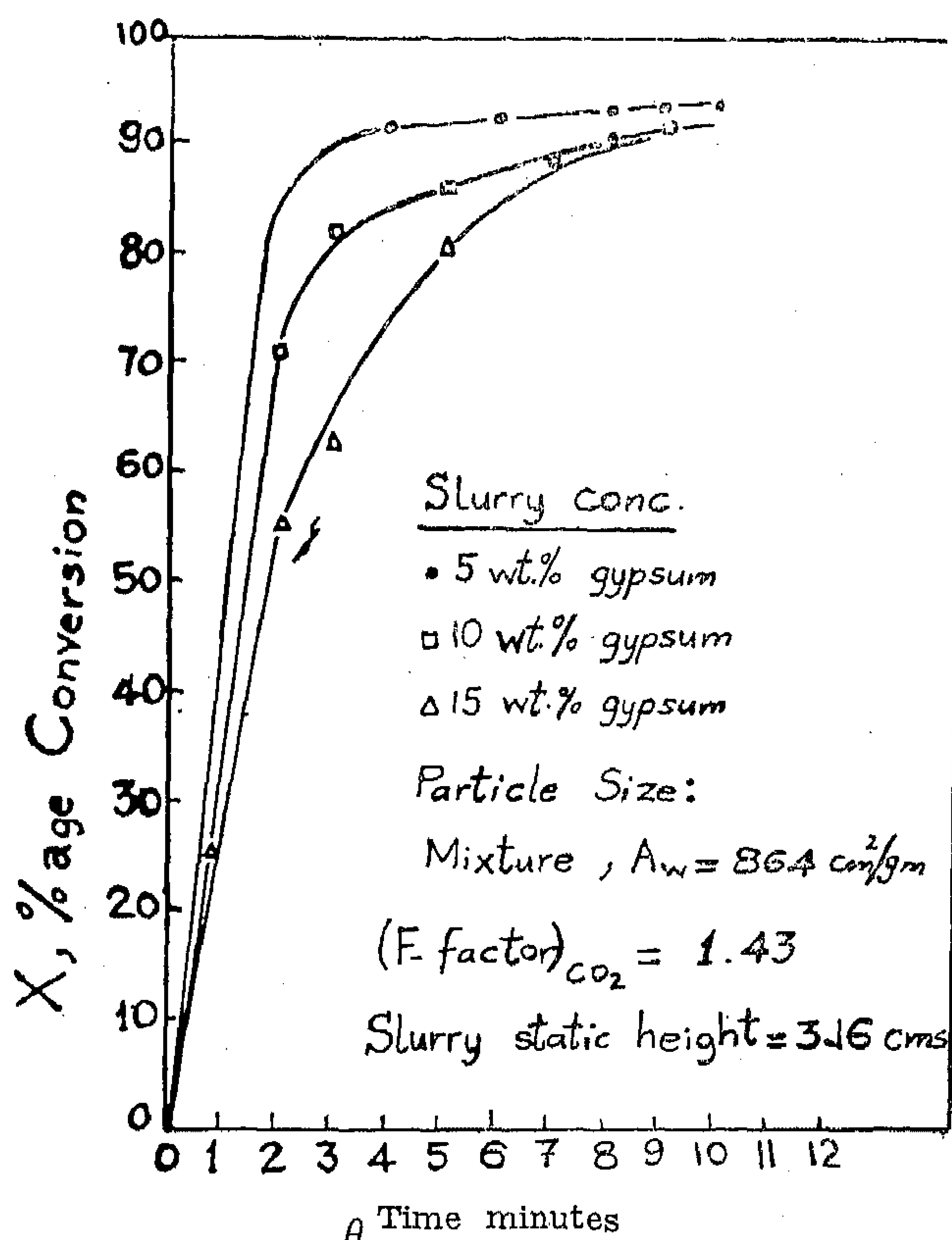


Fig. 4. Effect of gypsum conantration on % age conversion

(3. 4) Effect Of Slurry Static Height :

The factors fixed in this investigation are specified in Figure (5). It is observed from the figure that increasing the amount of slurry on the perforated plate results in increasing the conversion rate. This is explained as a result of the difference in the froth structure and height. With larger heights of slurry on the plate the froth was higher in addition to the fact that the liquid is dispersed in the form of droplets in the gas phase at lower static liquid heights and this imparts discontinuity and nonefficient mixing of the slurry during fluidization.

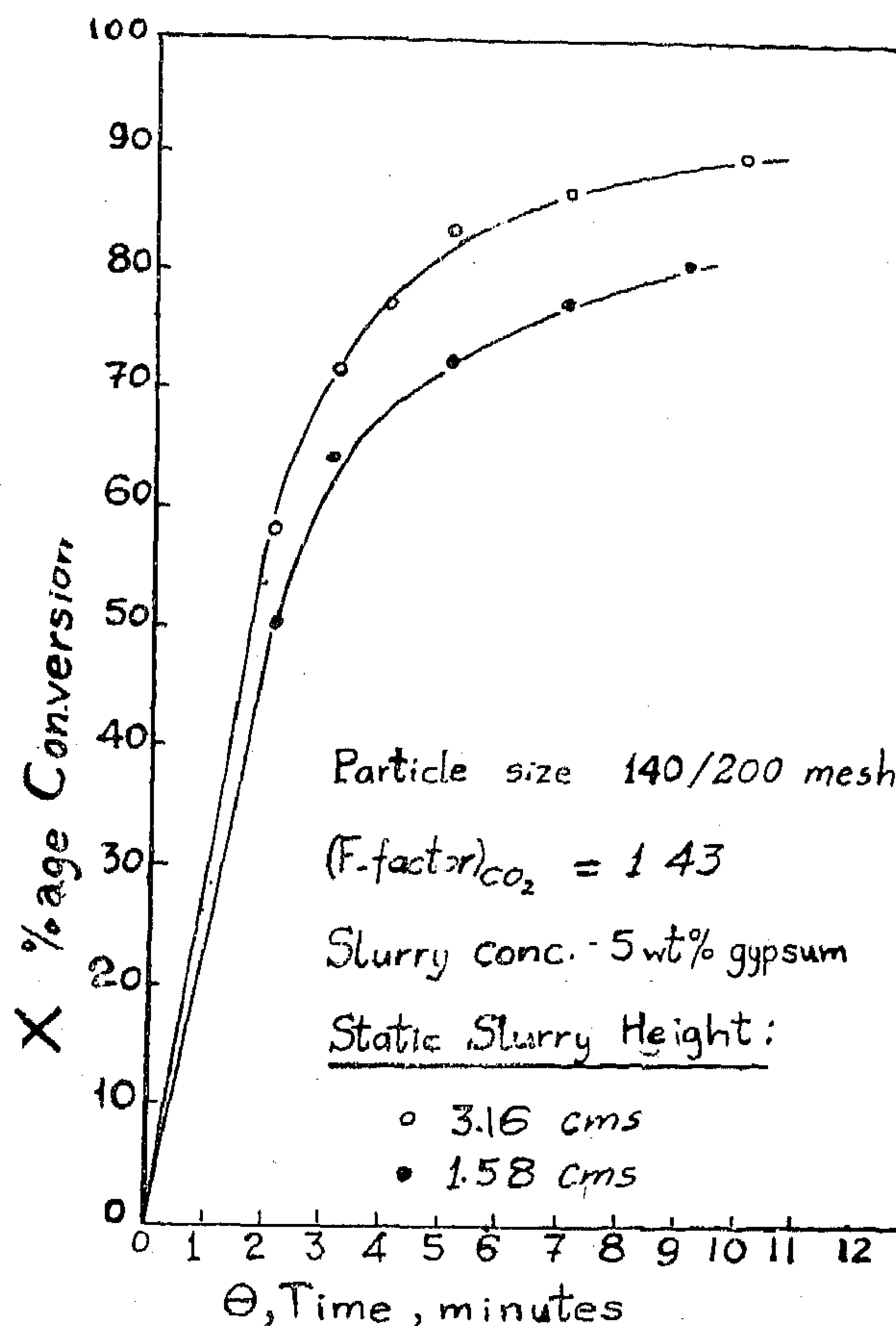


Fig. 5. Effect of bed heighton % age conversion

(3. 5) Effect Of Gas Rate :

The factors fixed in this investigation are specified in Figure (6) which illustrates the effect of changing the F-factor based on the superficial velocity of CO_2 on the percentage conversion during a fluidization period of 3 minutes. At the start the percentage conversion increases slowly with increasing F-factor to reach a maximum value of 85% at F = 1.6 which corresponds to a CO_2 superficial velocity of 36.5 cms/second. Beyond this rate the percentage conversion drops and it was visually observed in this case that the cellular structured froth started to change to a spray regime.

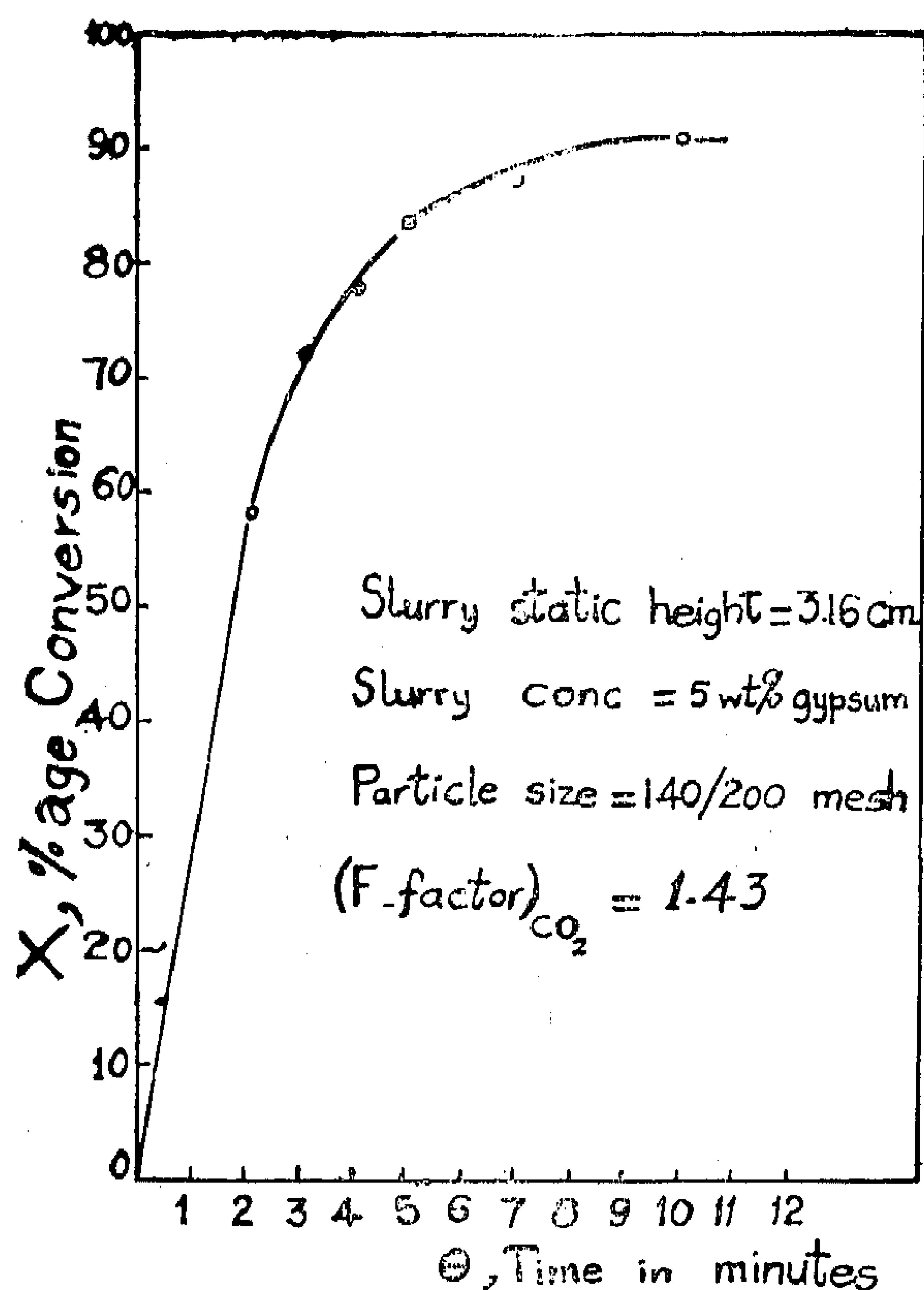


Fig. 2. Effect of time on % age conversion

270 mesh. The specific surface, Aw, of each sized fraction and the mixture were calculated applying the equations.

— for single sized fraction

$$A\ W = \frac{6\ \lambda}{P_p D_p}\ (\ cm^2/gm\ ) \qquad (1)$$

— for a mixtur eof different sized particles,

$$A_w = \frac{6\ \lambda}{P_p} \Sigma \frac{\Delta \phi}{D_{.p}} \qquad (2)$$

where,

λ = Particle shape factor

P_p = Particle density = 2. 368 gm/cm3

$\bar{D}_p$ = Arithmatic average dimension of the two screens pertaining the particle fract'on.

$\Delta \phi$= Mass fraction of particles retained between two consecutive screens.

It is observed from Figure(3) that the conversion is higher with smaller particles after the same period of fluidization. This is a result of larger surface area of particles exposed to the interaction with $(NH_4)_2CO_3$ in solution. The effect is well pronounced when comparing the fract'on — 270 + 325 mesh with the fraction — 140 + 200 mesh. In the former case the conversion reaches 91% after 3 minutes whereas in the latter case it only reaches 72% after the same period. It is also noticed that the conversion reaches 96% after 10 minutes with — 270 + 325 mesh particles.

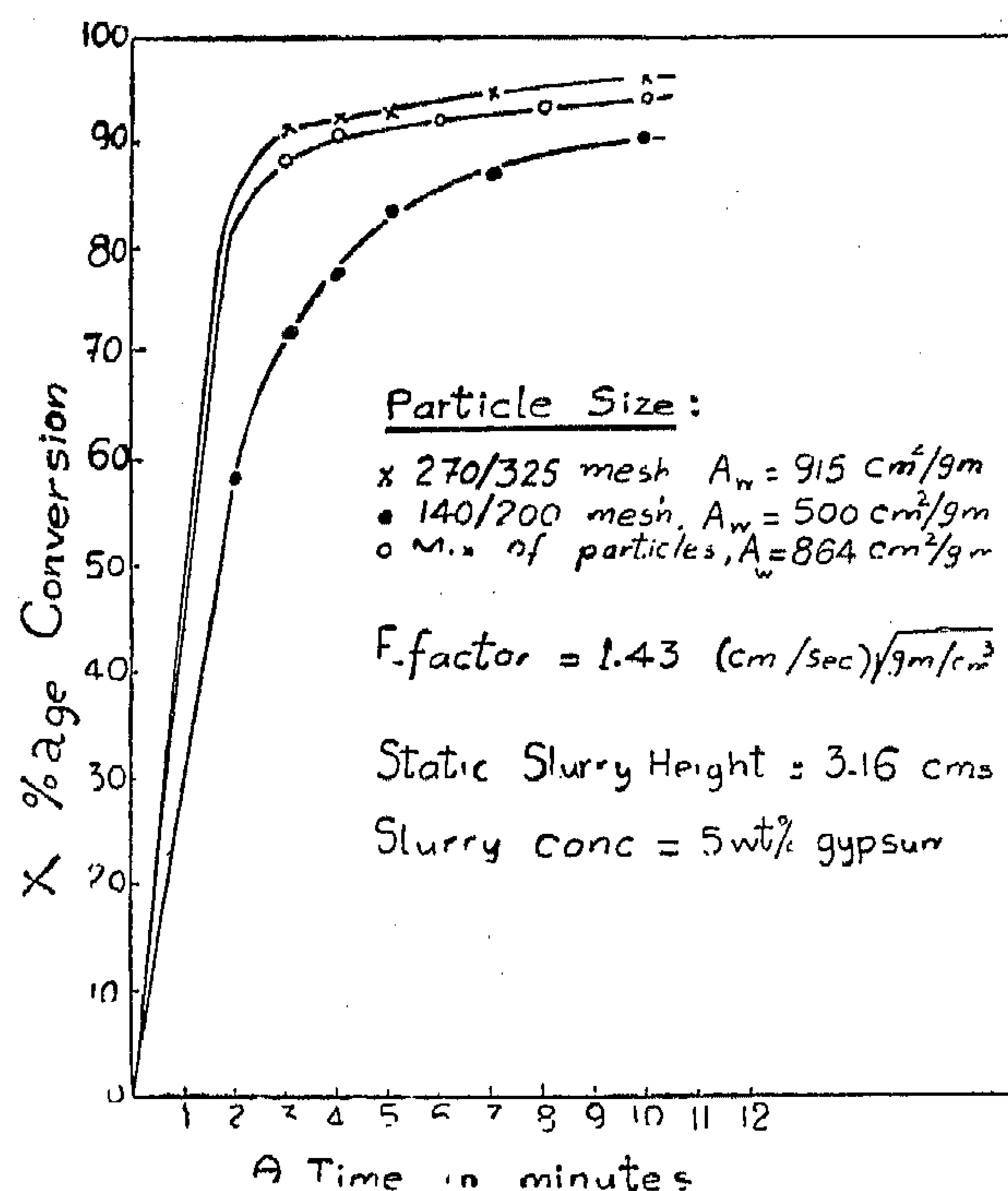


Fig. 3. Effect of partic'e size on % age conversion

(3. 3) Effect Of Gypsum Concentration In The Slurry :

The factors fixed in this investigation are specified in Figure (4). Slurries wth different gypsum concentrations of 5,10,15 wt. % were used. It is clear from the figure that higher conversion is achieved with dilute slurr'es for the same period of fliuidization. This is explained as

froth structure during operation was helpful in explaining the change in conversion rates at different operating conditions. Any slurry leaking through the perforated plate at low gas rates was returned back on the plate during operation. All experimental runs were conducted at room temp.

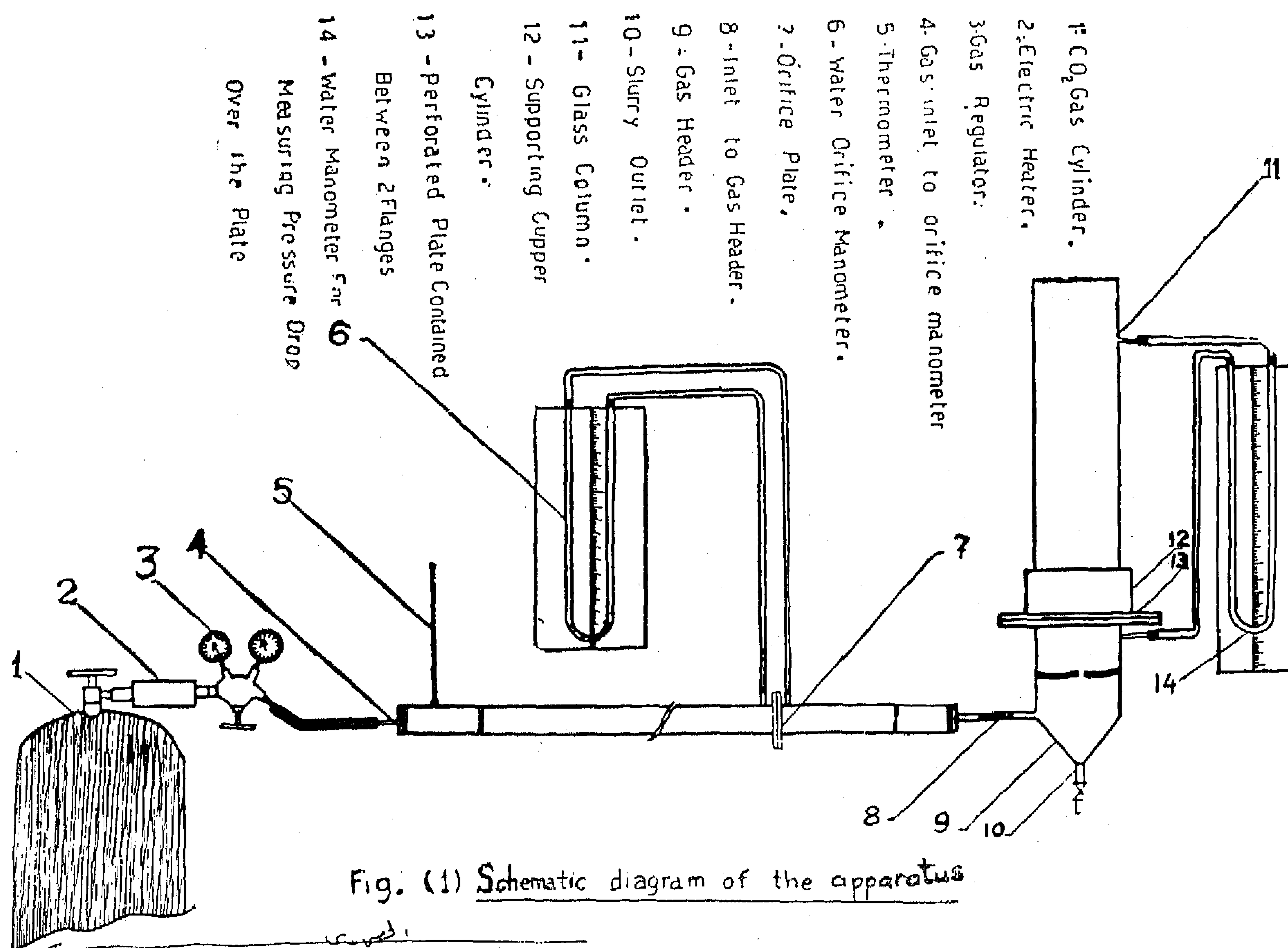


Fig. (1) Schematic diagram of the apparatus

3 — EXPERIMENTAL RESULTS AND DISCUSSION

The factors considered in this investigation are the effects of the period of fluidization, the particle size, the gypsum concentration in the slurry, the slurry static height ,and the gas rate on the percentage conversion of Ca SO_4 into $(NH_4)_2$ So_4 The temperature of the reaction mixture over the fluidization period was in the range between 28 — 38°c. The results of the study for each factor considered is given below in the following subsidiary items.

(3. 1) Effect of the Period Of Fluidization :

The factors fixed in this investigation are specified in Figure (2) which show a plot of the percentage conversion against the time allowed for fluidization. It is observed that the initial conversion rate is constant after which the rate of conversion decreases continuously. The percentage conversion increases with the increase of the time of fluidization.

(3. 2) Effect Of Particle Size :

The factors fixed in this investigation are specified in Figure (3). Two separate sized fractions of particles as well as a mixture of particles were used. The mixed sample consisted of 20 wt. % particles of 325/400 mesh, 40 wt. % particles of 270/325 mesh, and 40 wt. % particles of 200/

huge reserves of gupsum from which small quantities are exploited at the present for manufacturing anhydrous $CaSO_4$ at local manufacture works. A suitable method which opens a new field for the economic utilization of gypsum is based on converting $CaSO_4$ into $(NH_4)_2\ SO_4$ by thoroughly contacting a mixture of gypsum slurry, ammonia, and CO_2 .

Ganz et al(1) reported experimental investigations on the conversion of $CaSO_4$ into $(NH_4)\ SO_4$ through agitating a mixture of gypsum slurry, NH_3 and CO_2 in a mechanical disc mixer provided with a variable speed agitator. It was reported that increasing the number of revolutions of the agitator from 50 to 500 rpm results in increasing the conversion of $CaSO_4$ into $(NH_4)_2\ SO_4$ from 24% to 94% during the same period of 3 minutes. This was attributed to the mechanical destruction of the $CaCO_3$ film formed on the surface of the reacting gypsum particles at the higher agitator speed. It was also reported that much higher speeds result in only a slight increase in the percentage conversion. Investigations(1) are also reported on the effect of concentration of the reaction mixture on the degree of conversion. It was concluded that the greatest conversion rate was affected at concentrations of 64 gms/liter calcium sulphate and 57 gm/liter ammonium carbonate which corresponds to about 27% in excess of the stoichiometric requirement. The effect of temperature on the degree of conversion was also investigated and an optimum temperature between 28 and 38°C was reported for the highest conversion. Lowering the temperature to 23°C results in lowering the conversion rate.

As no data is reported in literature on the conversion of $CaSO_4$ into $(NH_4)_2\ SO_4$ at fluidized beds, it was found important to carry out investigations in this respect applying the fluidization of ammoniated gypsum slurries using CO_2 at perforated plates.

2 — EXPERIMENTAL WORK

A schematic diagram of the apparatus used is shown in Figure (1). It consists mainly of 7.6 cms diameter glass column supported on a perforated plate having 19 holes of ⅛ in. diameter o n4/8 in equilateral triangular pitch. The plate is fixed at the top of a gas header of the same diameter as the column in which the fluidizing gas is admitted through a standard orifice to measure its flow rate.

The raw material used is a representative sample from El-GHARBANIAT gypsum deposits in Egypt. Raw gypsum was crushed, ground, and separated into sized fractions by screening. Each fraction was chemically analysed to determine its content of $CaSO_4$. The density of the gypsum particles was determined as 2.68 gm/cm_3

In each experimental run a certain amount of ammoniated slurry of certain gypsum concentration and particle size was fed on the perforated plate while CO_2 gas was flowing upwards at a fixed flow rate for a certain fluidization period after which the gas flow was -stopped and the slurry with drawn from the bottom. The column was washed with distilled water and the washings added to the collected fluidized slurry. The mixture was then chemically analysed to determine the amount of converted $CaSO_4$ through the determination of the sulphate radical in solution. The amount of NH_3 in the slurry introduced for fluidization was 100% in excess of the stoichometric requirement which was found sufficient for the persistence of slurry alkalinity till the end of the run. Visual observation of the

CONVERSION OF CA SO_4 INTO $(NH_4)_2SO_4$ AT AMMONIATED GYPSUM SLURRIES FLUIDIZED BY CO_2 GAS

Dr. EL AGAMAWI Y.M., Dr. CHALABI

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ABSTRACT

The factors affecting the conversion of $CaSO_4$ existing in Egyptian raw gypsum into $(NH_4)_2SO_4$ have been experimentally investigated applying a fluidizing technique. Ammoniated gypsum slurries of different concentrations were fluidized by CO_2 gas flow at a perforated plate Single sized fractions of particles as well as mixtures were used ranging in specific surface from 500 to 915 cm ^{2} /gm. Slurry static heights on the plate equalled 1.58 and 3.16 cm, and gas rates corresponding to F- factors ranging from 1 to 1.7 $\left(\frac{cm}{sec.}\sqrt{\frac{gm}{cm^3}}\right)$ were applied. It has been found that at the initial conversion stages the rate of conversion is constant after which it decreases continuously. The conversion rate increases with the increase of the specific surface of particles. Increasing the gypsum concentration in the slurry results in decreasing the conversion whereas increasing slurry static height on the plate increases the conversion.

A maximum percentage conversion was achieved at a CO_2 flow rate that corresponds to an F — factor of 1.6 Equations are presented to express the different conversion rates.

On comparing the experimental results with mathematical models it was possible to identify the rate controlling step during the conversion. At early stages of cotacting the phases the conversion is controlled by diffusion of $(NH_4)_2CO_3$ through a laminar liquid film surrounding the particles whereas at latter stages it is controlled by diffusion through an ash layer of $CaCO_3$ formed on the particles.

1 — INTRODUCTION

Ammonium sulphate is one of the most important fertilizers for alkaline soil. It is characteterized by its dual acidifying effect on the soil and by its higher resistance to leaching which makes it favourably to Egyptian soil. Egypt still imports considerable amounts of this fertilizer to cope with its needs over the quantities locally manufactured. Due to shortage of sulphur and sulphide ores necessary for manufacturing sulphuric acid in Egypt it was thought to apply a suitable method for manufacturing the fertilizer using local natural resources. Egypt has

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(b) The use of heated excess air in firing the furnaces should be increased, since the emission gases temperature has a marked effect on the value of ground-level concentrations via increasing the thermal-rise.

(c) The injection of hot air within the stacks should be encouraged to increase the velocity-rise and emission rate that tends to increase the effective stack height.

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This difference may be clarified by noting that the exit gases temperature is different. In section (F-2) of Plant (C) it is 572°F, and in case of section (F-2) of Plant (D) it is 302°F. Thus it is clear that lowering the exit gases temperatures increases the Air Pollution level.

(e) The highest measured Sulfur dioxide pollution at the Mostorod location is within and near Plant (D). The pollution level ranges from 1.1 to 2.9 ppm. The opposite is observed in Plant (C) and (B) in which the pollution is almost zero during daytime, and ranges from 0.1 to 0.3 ppm, during the night.

(f) Comparing the measurements, at points (3) and (4) within and near Plant (D), it is clear that the Sulfur dioxide pollution level at the first point (2.2 to 2.9 ppm) is higher than at the second point (1.1 to 1.7 ppm) in spite of the fact that the distance between the points is only about 60 feet. This may be only due to a process leakage rather than to any other factor.

(g) Comparing the measurements at points (1) and (2), it is clear that at the first point the pollution level-ranges from 0.9 to 1.6 ppm and at the second point from 0.7 to 1.5 ppm. Since the measurement point (1) is more down-wind than point (2), its pollution level is higher. From this observation it is expected that the maximum ground-level concentration lies outside the Mostorod site boundaries.

(h) The calculated Sulfur dioxide pollution is less than the measured value by a factor ranging from 1.96 to 13. This agrees with the work of MOSES, STROM and STOMKE (7). However, the above observation disagrees with the work of SMITH (6) and EISENBUO and HELMERS (4). From the estimation of the Sulfur dioxide pollution and its measurement, it is clear that the pollution estimated by using the BASANQUET formulas should be multiplied by a factor of about 7.5 within the Mostorod location.

(f) Using Statistical Analysis to test if a difference exists between the estimated pollution under stable and unstable air conditions, it was found that no difference exists. However, using the same test in the case of the measured pollution at Mostored under stable and unstable air conditions, it was found that a difference exists. Thus the measured results agree considerably with the well known fact that a difference should exist. This indicates that the BOSANQUET formulas, although the best of their kind, are not influenced by the prevailing air conditions if the wind-speed excets 10 fps.

RECOMMENDATIONS

This research work has shown that the Mostored Refinery-Pipeline Terminal is not Sulfur dioxide polluted to an extent that the operators health is in danger. The maximum Sulfur dioxite level reached within the Mostrood location is about 2.9 ppm at plant (D) which is less than the limiting tolerable level of 5 ppm. The following recommendations are suggested to lessen the pollution in Plant (D)

(a) The stacks heights of Plant (D) should be increased. This helps to decrease the value of the ground-level concentration of Sulfur dioxide, since it was found that the controlling factor was the actual height of the stacks.

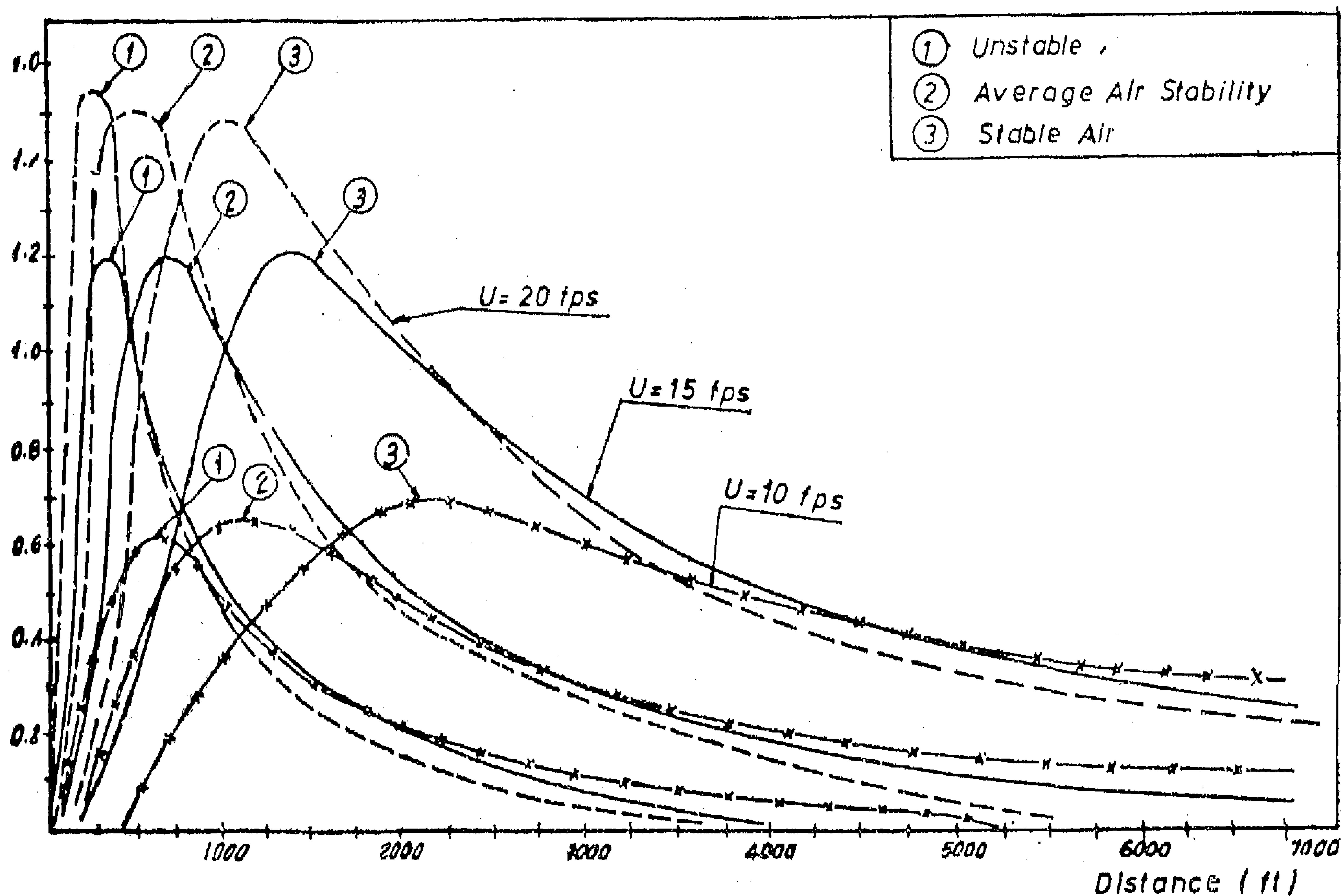


Fig. 5. The variation of the GLC with distance from plant (D)

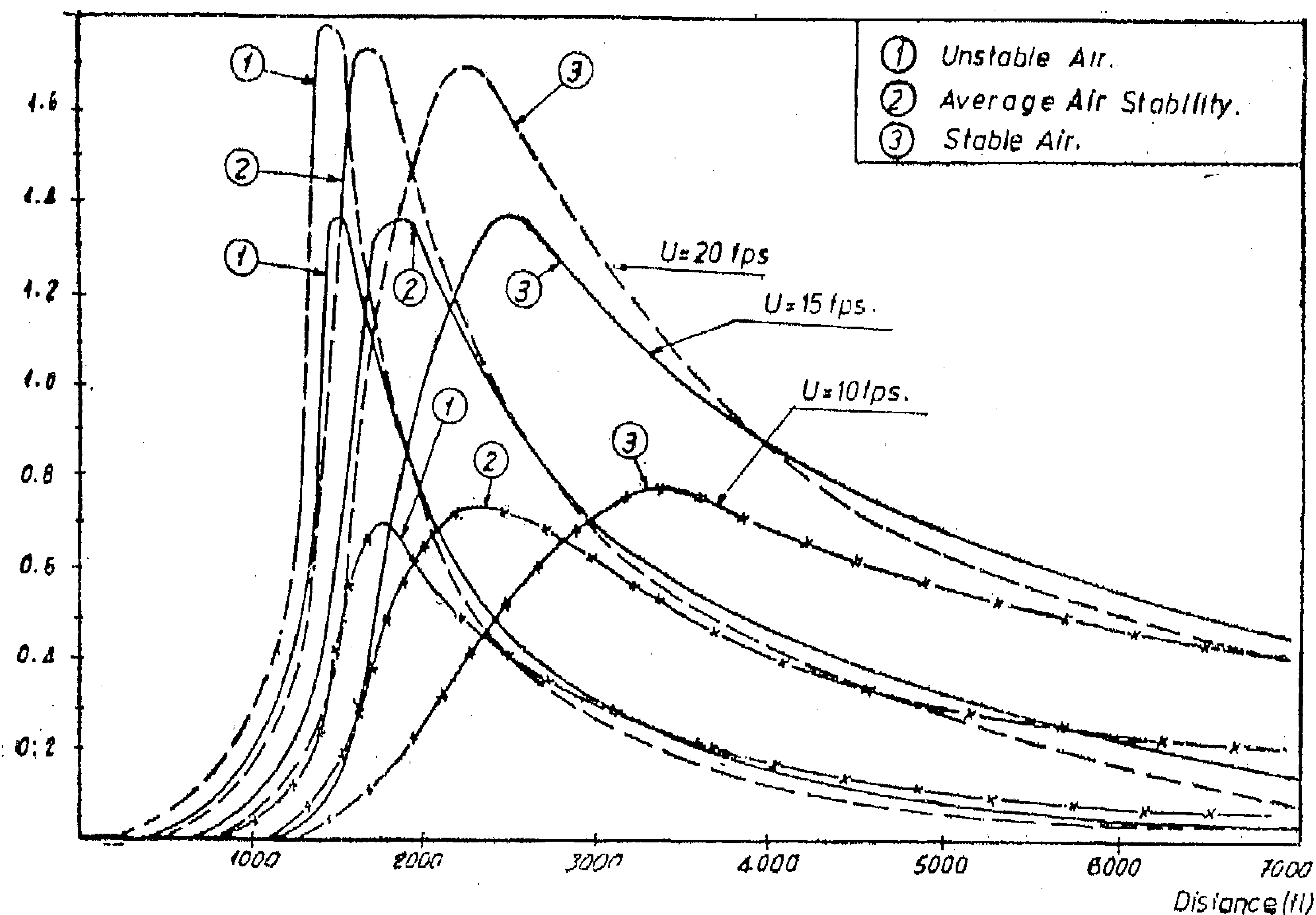


Fig. 6. The variation of the overall GLC of the Mostorod Reunery with distance from plant (C)

calculated by using the Bosanquet equations. The second aim was to detect and measure any leakage which may cause an Air Pollution problem in the vicinity of the Furnaces, Tanks, and Processing Columns. Sampling points (1), (2), and (6) are taken to represent the first categovy, while sampling points (3), (4), (5), (7), and (8) represent the second category.

The GAS-DETECTOR reviewed in part one was used to determine the Sulfur dioxide concentration at the different points of the Mostorod site. The measurements were repeated at different times of the day They were taken before sunrise, after sunset, and during the daytime. This was done to show the effect of the air tempetature on the value of ground level concentration at a certain location. The results obtained for each location at different air velocities were checked by statistical analysis (t-test) to de termine if they are statistically different or not. Also, the difference due to the atmospheric temperature was checked.

Observations and Conclusions :

(a) As the wind-speed increases, the difference between the catculated Sulfur dioxide pollution level under stable and unstable air conditions decreases. Thus the effect of the temperature lapse rate can be safely neglected. The controlling factor of the pollution becomes the Actual-Stack-Height at the Mostorod location. By using Statistical-Analysis it becomes clear that no difference exists between the calculated Sulfut dioxde pollution level under satable and unstable air conditions.

(b) Under the prevaiting wind-speed at Mostorod of 9 to 16 ft/sec., the highest calculated Sulfur dioxide pollution source is Plant (D). This is mainly due to the fact that plant (D) consists of many sections and its stacks are not high. It is to be also noted that the extent of the pollution of Plant (B) and (C) is quite limited, mainly due to the relative heights of their stacks. Table (1) gives the maximum ground-level concentration value and its location for the four Plants at Mostorod.

(c) In spite of the fact that section (F-2) of Plant (B) is similar to section (F-1) of Plant (A), it was found that the calculated Sulfur dioxide pollution is higher in case of section (F-2) of Plant (B). This difference may be explained by pointing out that section (F-1) has one stack and section (F-2) has two sracks. Thus, the rate of emission is less in case of section (F-2) per stack and this affects the plume-rise, and consequently the extent of poloution.

(d) In spite of the fact that sections (F-2) of Plant (C) is similar to section (F-2) of Plant (D), the calculated Sulfur dioxide pollution is higher in case of section (F-2) of Plant (D).

Table (1) Maximcm — Ground — Level — Concentration at Mostorod Pants.

Plant	M.G.L.C. (ppm)	Location of M.G.L.C. (ft)	Plant	M.G.L.C. (ppm)	Location of M.G.L.C. (ft)
A	0.01 to 0.03	1500 to 600	C	0.03 to 0.05	700 to 2850
B	0.41 to 0.116	1000 to 4100	D	0.616 to 1.37	320 to 1300

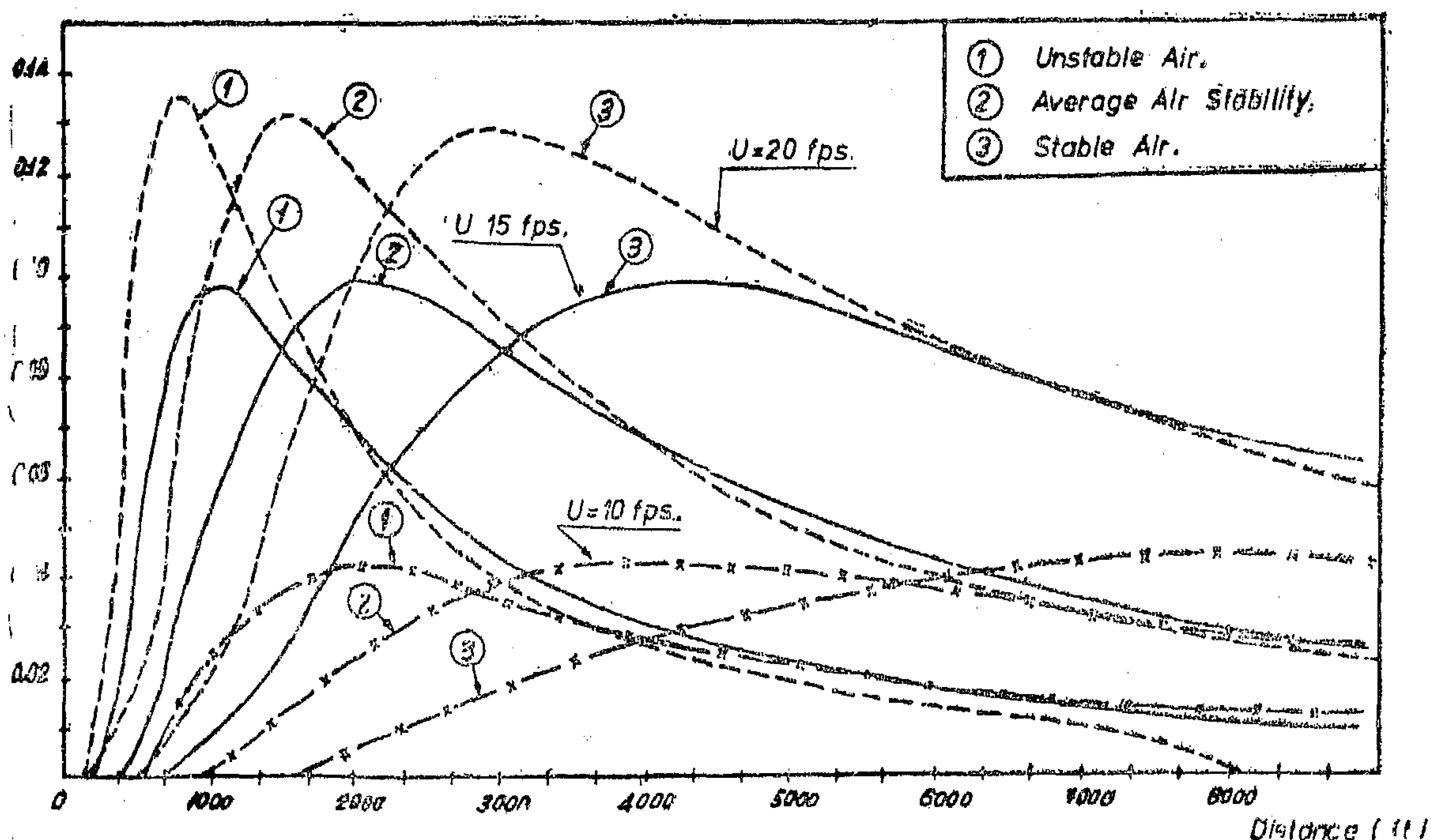


Fig. 3. The variation of the GLC with the distance from plant (B)

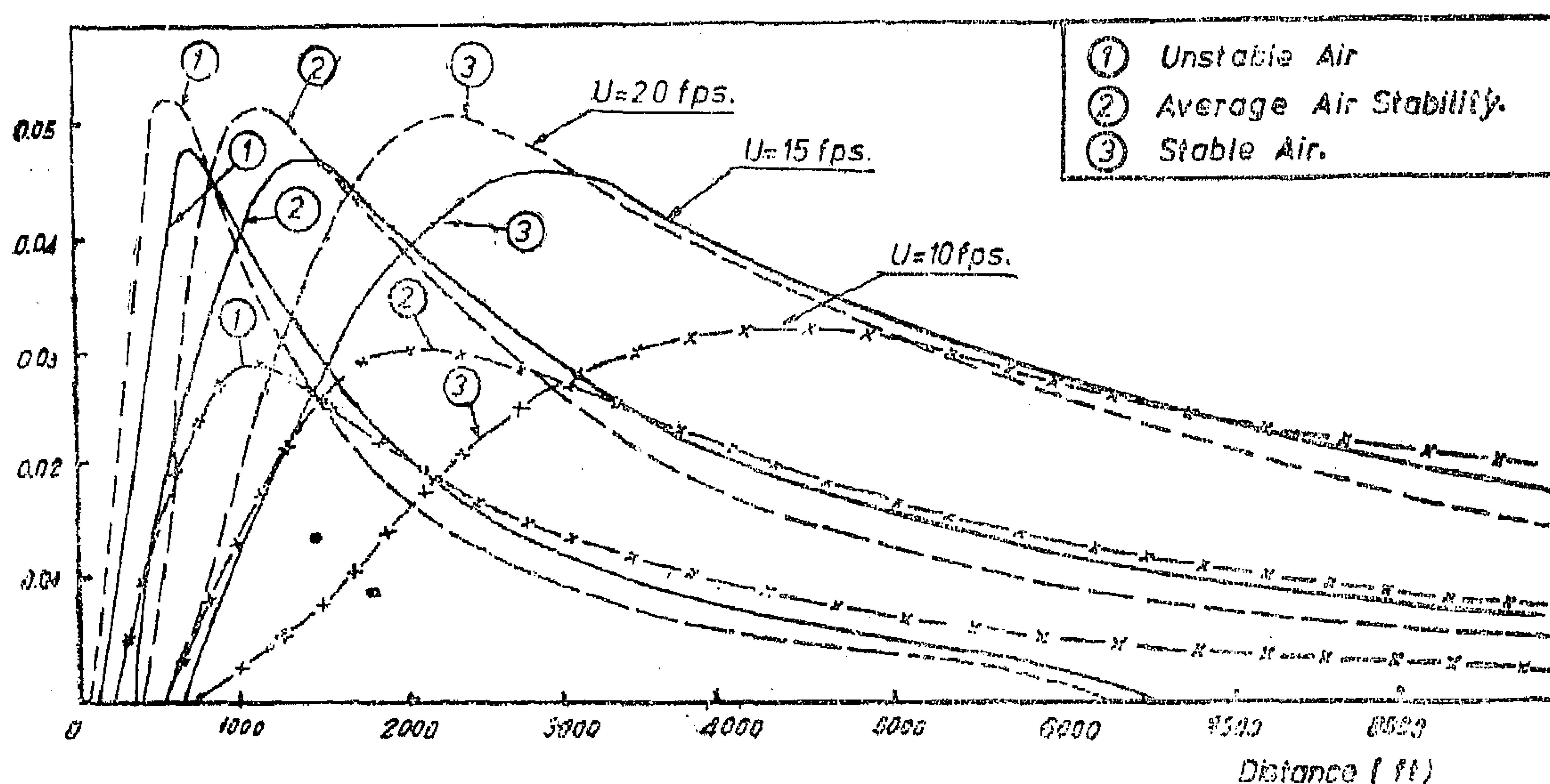


Fig. 4. The variation of the GLC with distance from plant (C)

unstable air conditions. The results of such calculations are represented in Fig. (6).

Procedure for the Experimental Determination of the Sulfur dioxide pollution at Mostorod :

A periodic analysis is made at the Mostorod site to check the efficiency of the different furnaces. The volume percent of Sulfur dioxide issuing from the Mostorod stacks ranges between 0.8 — 1.0%. The location of the sampling points within the Mostorod site were chosen keeping in mind two aims. The first is to compare the measured Sulfur dioxide pollution, within the site, to that

Figure (1)

Gasoline storage area
Crude oil storage area
Kerosene storage area
Fuel oil storage area
Gas oil storage area
Waste-Water Treatement area
Plant "C"
Plant (B)
Plant (A)
Plant (D)
(F-1) (F-2)
Wind Direction
E N S W
1 2 3 4 5 6 7
Drawing scale

LOCATION OF THE POLLUTING STAKS. OF THE MOSTOROD LOCATION
Scale 1 : 200 meters
Polluting source
Location of samples taken in the wind direction
Location of samples taken at the polluting source
Stack

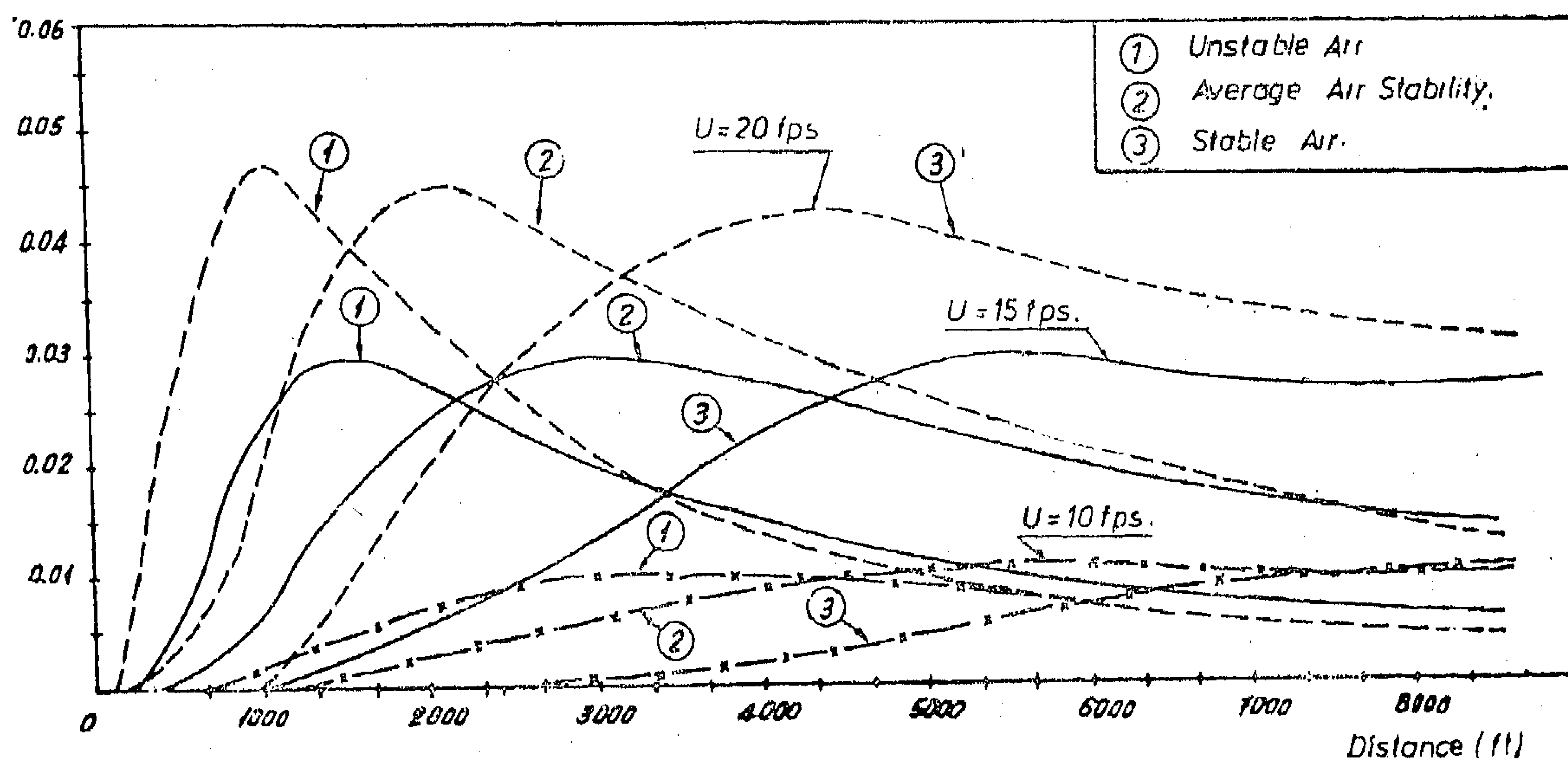


Fig. 2. The variation of the GLC with the distance from plant (A)

AIR-POLLUTION AT THE MOSTOROD REFINERY AND PIPELINE TERMINALS

— PARE 2 —

By

Dr. M. HUSSEIN, Dr. M. BADR*

and Eng. M. AHMED**

Part one reviewed the necessary background needed to understand and evaluate Air Pollution problems. Part two will deal with the theoretical estimation and experimental measurements of the sulfur dioxide pollution at the Mostorod site. A lay out of the site is given in Fig. (1), from which it is clear that it can be divided into four main plants : (A), (B), (C), and (D). Plants (A) and (B) are atmospheric fractionation units, plant (C) is known as the Asphalt plant, while plant (D) consists of a group of boilers and pipeline furnaces. In Fig. (1) is indicated the locaton of the stacks of each plant, as well as, the location of the measuring points.

Procedure for the Theoretical Estimation of Sulfur dioxide Pollution at Mostored :-

The Bosanquet formulas (1,2,3,5,7) were used to estimate the Sulfur dioxide centration (MGLC) and finally the GLC at diffevent distances from the polluting stacks of the different plants of the Mostorod site. There are involved in this procedure about twelve equations to be used simultaneously which determine the stack velocity, the thermal-rise, the velocity-rise, the maximum-ground-level-concentration (MGLC) and finally the GLC at diffevent distances from the polluting stack.

The above procedure was repeated for each polluting stack using different wind speeds ranging between 7 to 20 fps. This wind speed range represents the, prevailing wind speeds at Mostorod through the year. The procdure was also repeated for the case of stable and unstable air conditions at the different wind speed variations. The results are shown in Figures (2), (3), (4), and (5) which represent plants (A), (B), (C), and (D) respectively. The results obtained for each polluting section were checked by using Statistical Analysis. The GLC under stable and unstable conditions were tested by using the "t-test" to find-out if they are statistically different or not. This procedure is thought necessary to check the signitcance of the results of any method of calculation under different prevailing conditions. The over-all pollution from the four plants at Mostorod was then calculated, using plant (C) as the pollution-origin-point since it is the first polluting plant upwind as can be seen from Fig. (1); by using the GLC of the different plants, under stable and

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- ترسل النصوص المطلوب موافقة هيئة التحرير على نشرها باسم السيد / رئيس التحرير . وهو غير مسئول عن فقد أو تلف أى نص .
- تنشر المجلة المقالات التى تسهم فى رفع مستوى العلوم الهندسية وطرق ممارستها .
- تقبل للنشر المقالات باحدى اللغتين العربية أو الانجليزية ، على أن تقدم من ثلاث نسخ مكتوبة على الآلة الكاتبة ومعها ملخص بكل من اللغتين .
- تذكر أسماء أصحاب المقالة كاملة باللغتين ومعها ألقابهم العلمية ووظائفهم .
- يراعى الا تتجاوز المقالة ٨ صفحات بالمجلة ، وفى سبيل ذلك يختصر الاشتقاق الرياضى ويستعاض عن الجداول بمنحنيات مرسومة بالحبر الشينى الأسود ، على أن يشغل المنحنى نصف صفحة على الأكثر ولا يشغل صفحة كاملة الا فى حالات استثنائية وسيصغر أى منحن الى تلك المقاسات .

  ويراعى الا يقل ارتفاع الحروف أو الأرقام على المنحنيات المنشورة عن ٣ مم بعد التصغير .
- يعنى بذكر المراجع المستقى منها المقال وتصنف تبعا لاسم المؤلف ثم العنوان ثم المجلة أو الكتاب وتاريخه .
- تقدم لصاحب المقال تجربتان للطباعة وترفق بالأولى نسخة من مصطلحات التصحيح التى يؤدى اتباعها الى رفع كفاية التصحيح وتقليل الوقت الضائع فيه .

اشتراكات الجمعية :

	قرشا
العضو	٢٠٠
العضو المنتسب	١٥٠
المنتسب	١٠٠

اشتراكات المجلة :

يتلقى أعضاء الجمعية نسخهم مجانا .

ولغير الأعضاء :	قرشا
الاشتراك السنوى للمهندسين	١٠٠
الاشتراك السنوى لغير المهندسين	٣٠٠
الاشتراك السنوى الهيئات	٥٠٠

تعطى أولوية النشر بالمجلة السادة الزملاء أعضاء جمعية المهندسين المصرية

الاعلانات :

مؤسسة مصر للطباعة والنشر

القاهرة ١٩ شارع سوق التوفيقية ت ٧٢١٩٢

رقم الايداع بدار الكتب ١٩٧٤/٢٩٨

محتويات العدد

التشييد والبناء

القسم العربى :

القسم الافرنجى :

التصنيع والانتاج

القسم العربى :

القسم الأفرنجى :

الخامات الأولية والصناعات الكيميائية

القسم العربى :

القسم الأفرنجى :

التشييد والبنـــاء

جمعية المهندسين المدنيين
جمعية المهندسين المعماريين
جمعية مهندسى الرى

DAY 3 TOESDAY 22 APRIL 1975

0900 **SESSION 8**

IMPLEMENTATION OF HOUSING GOALS

Private & public decision making
Role of the Governmental Agencies

1100 **SESSION 9**

PROJECT MANAGEMENT

Preconstruction planning
The life-cycle aspects of planning, design, construction and use of buildings, ranging from conception to final demolition.

1500 **CAIRO TOUR**

Visit to Cairo housing developments

oooOooo

DAY 4 WEDNESDAY 23 APRIL 1975

0900 **SESSIN 10**

HOUSING SYSTEMS AND METHODS

Structural Systems, foundations and construction
Levels of training
Role of building industry
Prefabrication

1100 **SESSION 11**
SERVICES

Mechanical, electrical, ventilation
Water supply and wastes
Energy considerations

1600 **SESSION 12**

SAFE HOUSING & SAFE HOMES

Wind and other loads
Fire, accident and security

DAY 5 THURSDAY 24 APRIL 1975

0900 **SESSION 13**

APPLICATIONS : STEEL AND MIXED CONSTRUCTION

Design case studies in steel and prefabrication

1100 **SESSION 14**

APPLICATIONS : MASONRY SYSTEMS

Design case studies

1600 **SESSION 15**

APPLICATIONS: CONCRETE SYSTEMS

Precast, prefabricated and cast in situe systems

1800 **CLOSING SESSION**

Review and closing addresses

DAY 6 FRIDAY 25 APRIL 1975

0800 Visit to Suez Canal Zone : Housing Needs

oooOooo

DAY 7 SATURDAY 26 APRIL 1975 AND

DAY 8 SUNDAY 27 APRIL 1975

Post Conference Tour: Visit to Luxor, Aswan, and Abu-Sinbel
Advance registeration requested.
Registeration fee will be announced leter.

Dr. G. NASSAR

PRELIMINARY PROGRAM

DAY 1 SUNDAY 20 APRIL 1975

0830 Registration

1030 Welcome
Dr. A. Moharram
Egyptian Society of Civil Engineers

Address
H.E. Dr. A.M. Abul Azm
Chairman, Egyptian Academy of Science and Technology

Address
Director, National Science Foundation, USA
Dr. H. Guyford Stever

Address
Dr. Lynn S. Beedle
Chairman, Joint Committee on Tall Buildings, USA

ADDRESS UNESCO

Opening Speech
H.E. Eng. Osman Ahmad Osman
The Minister of Housing & Reconstruction

1230 **SESSION 1**

GLOBAL NEEDS OF HOUSING

Speaker
UNESCO

1600 **SESSION 2**
RECENT SOLUTIONS AND EGYPT'S NEEDS

1800 **SESSION 3**
HISTORICAL ASPECTS & CULTURAL VALUES

Housing for masses
Philosophy of High Rise & Low Rise Density
Architectural Criteria

oooOooo

DAY 2 MONDAY 21 APRIL 1975

0900 **SESSION 4**

URBAN PLANNING: HOUSING, TRANSPORT, LAND USE

Siting
Transportation for work & leisure
Amenities

Employment opportunities

1100 **SESSION 5**

ECNOMIC ASPECTS

Local, Regional and National Resources
International Assistance programs
Economic factors in choosing house systems & materials

1530 **SESSION 6**

SOCIAL EFFECTS

A house or a home?
Culture shock
Town life
Crowding, Families, Elderly...

1715 **SESSION 7**

MAINTENANCE & MANAGEMENT

Home ownership
Managing housing estates

NOTES ABOUT THE CONFERENCE, cont.

Schedule and Program. The tentative program is attached. It consists of 15 sessions.

Typical Session. There will be two **co-chairmen**, one from Egypt, one from outside who would preside over the sessions. The **speakers** will each have 10 minutes. Usually there will be four: two from Egypt, two non-Egyptian. There will follow open discussion and questions from the floor. The co-chairmen will be asked to prepare a one- or two-page summary of each session and submit it for distribution the following day.

Manuscripts and Preprints. Speakers and Discussers should send a two-page summary highlighting their findings or observations by March 15 so that they can be available as Preprints to stimulate the discussion. Two or three principal references should be included. One page of illustration (black and white only) could be included, if desired, suitable for reproduction.

These two-page summaries should be sent to Cairo (copy to Headquaters).

Larger manuscripts will be acceptable if they constitute completely new contributions. (They will be available to those who request them. Ten (10) copies should be supplied; to Cairo and 5 to Headquarters). Rather, the conference organizers are desirous of focusing attention at this occasion on contributions to the MONOGRAPH on Tall Buildings.

Communitions to Cairo should be addressed :

Dr. Gamal Nassar
Conference Secretary
Egyptian Society of Civil Engineers
28 Ramses Street
Cairo, Egypt

Cables to Cairo should be addressed:
Mohandsoun, Cairo
c/o Dr. G. Nassar

CAIRO CONFERENCE

ON

LOW COST HOUSING IN DEVELOPING COUNTRIES

CAIRO: 20-25 APRIL 1975

EGYPT

NOTES ABOUT THE CONFERENCE

OBJECTIVE OF CONFERENCE :

In brief, the objective is a two-fold one :

(1) To discuss low-cost housing as it applies to Egypt and other developing countries, and including both alternatives of highrise and low-rise.

(2) To bring together the leaders of the Joint Committee (who will in the main be the non-Egyptian chairmen, speakers, and reporters in order to have a final review of Draft 1 of the MONOGRAPH on Tall Buildings.

The exploding population in developing countries has created an urgent need for housing, housing which must be economic yet human, safe yet compact, livable yet socially acceptable. Increasing consideration is being given to the role of tall buildings in filling these needs. Yet, the tall building introduces its own effects, and these must be considered with the end objective in view.

The emphasis is given to "housing" for a number of reasons. First it is such an urgent need in so much of the world. Second, both economic and energy conservation reasons require a consideration of high-rise housing. Third, the rapid increase in population coupled with disappearing agricultural land (precious arable land is being rapidly absorbed by low-density suburbs) strongly point to more "vertical living" in the future.

It is expected that the Conference Week will attract as many as 150 specialists from all parts of the world — about 30 of these specialists will attend with separate financial support. Such a concentration of expertise will be unprecedented, and will be fully utilized in the following ways :

(1) the experts will present lectures at the plenary sessions.

(2) they will participate in the workshops relevant to their expertise, and lead the discussions.

(3) they will be available to give advice to practical problem which exist either within Egypt or elsewhere in the world.

(4) they will be available to give special lectures in Cairo outside the framework of the Conference... e.g. universities or engineering societies.

(5) they will participate in the anticipated Seminar to be arranged together with the Ministry of Reconstruction of Egypt on the subject of "The Redevelopment of the Suez Canal Zone". This offers a singular opportunity for Egypt to make use of such a large number of top experts and to establish a standard for similar future development. The focus of this Seminar will be the residential and community programs for the retuning population, for the technical manpower, for construction and for industrial and port development.

CAIRO CONFERENCE
ON
LOW COST HOUSING IN DEVELOPING COUNTRIES

CAIRO : 20-25 APRIL 1975

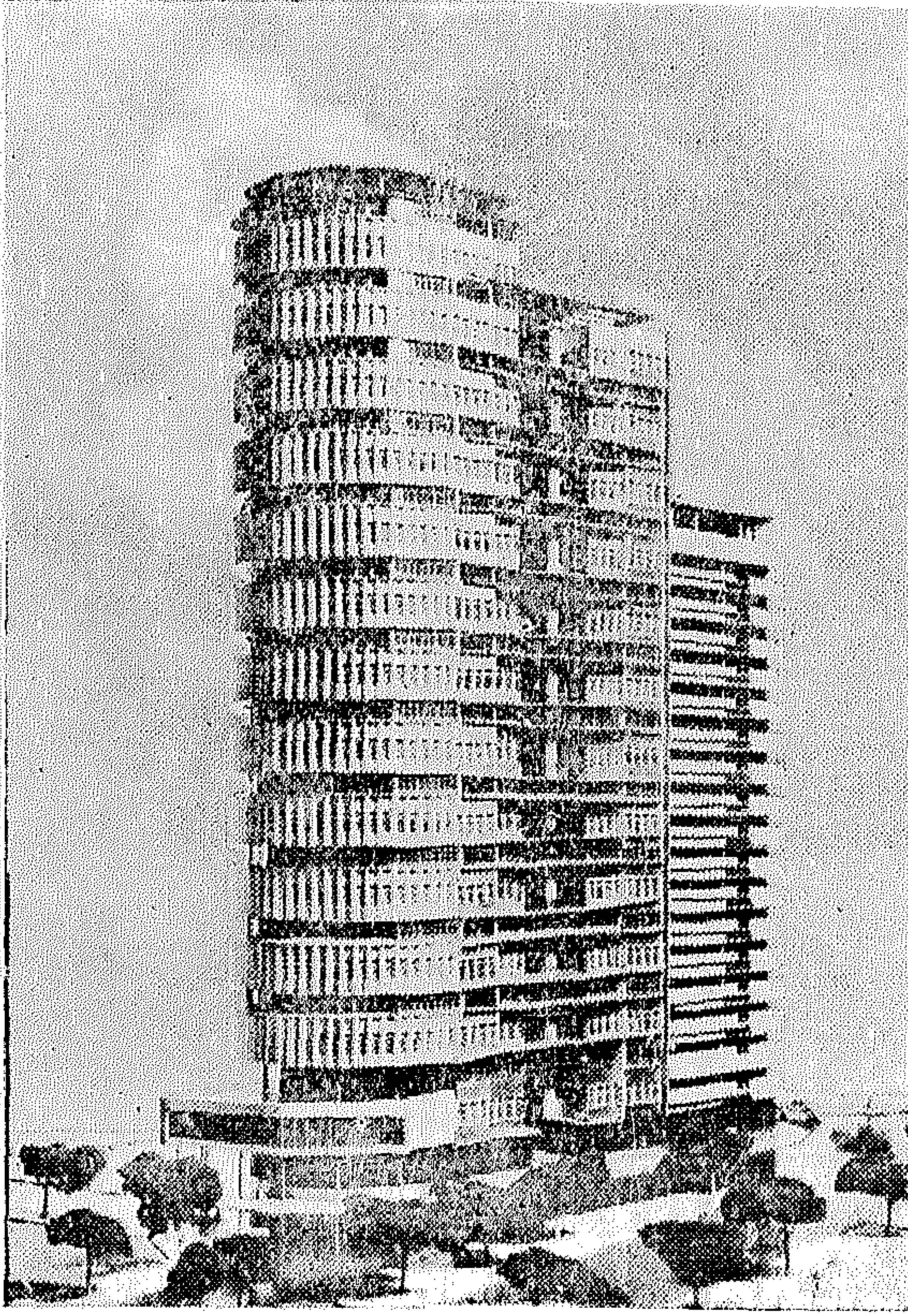
EGYPT

الاكولوجيا .. والمبانى العالية

المعمـــارى دكتور سيد كريم

Ecology & Tall Buildings

Dr. Sayed Karim.



العمـــارة السكنية المتكاملة ـــ مشروع
برج الصباح المقترح بالزمالك / القاهـرة

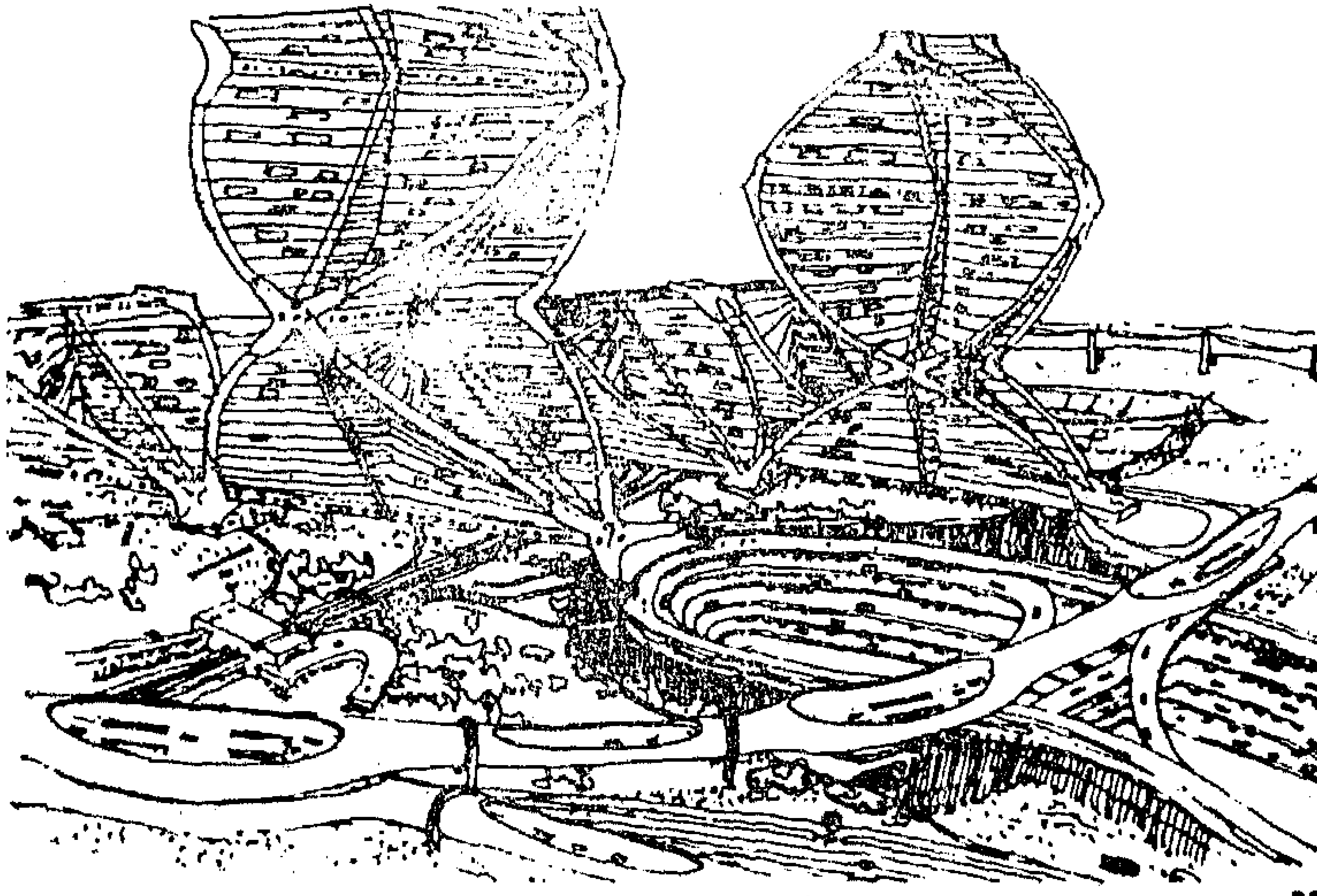
سجل المؤتمر الدولي للعمارات العالية الذى انعقد بالقاهرة فى مارس ١٩٧٤ واشترك فيـــه مجموعة من الخبراء العالميين من ١٨ دولة ، سجل بحثا علميا يحل مشكلة المبانى العالية وعلاقتهـا بتلوث البيئة الـذى يعتبر من أهم المشاكل التى تشغل علماء التعمير وتخطيط الـمدن . والبحث المصرى تقدم به الدكتور سيد كريم واشتمل على عدة نظريات جديدة فى تصميم عمارات الغــــد التى يواجه بهـا مشـكلة الانفجار السـكانى ومشاكل البيئة .

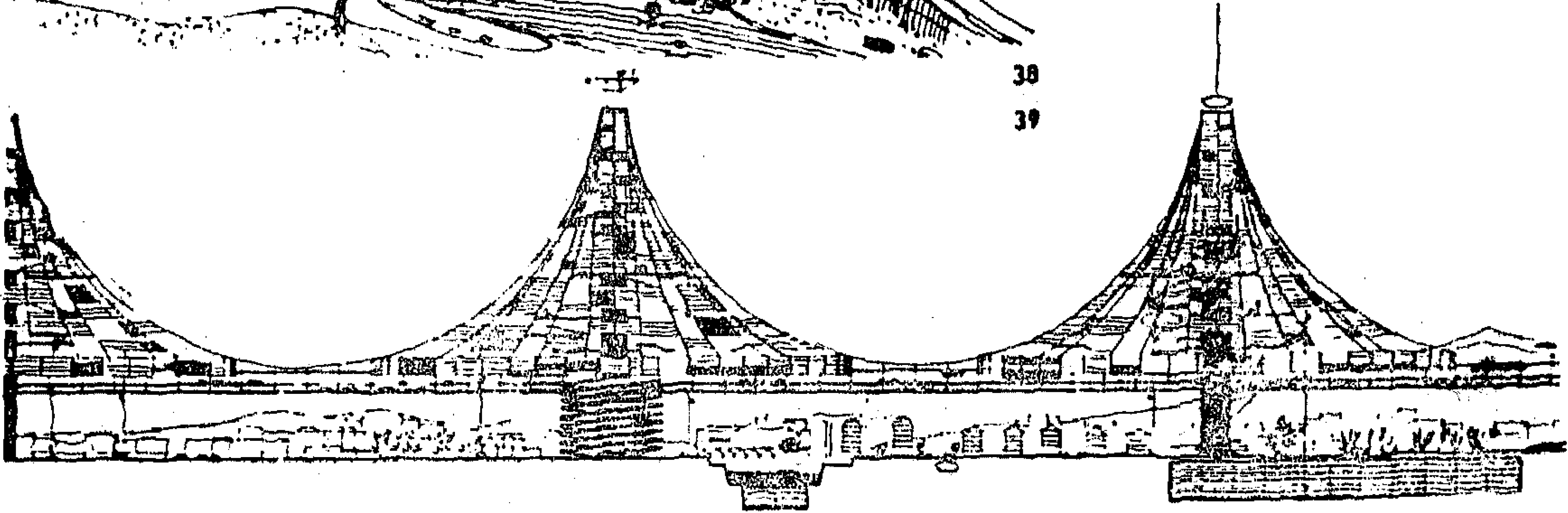
● منذ فجر الحضارة والعمارات العالية أو الأبراج المعمارية كانت حلم المعماريين .. وخلال رحلة التاريخ الطويلة فى العمارة وتخطيط المدن كافحت تلك المبانى لتحديد خط السماء **خط سما الحضارة .**

ان مصر **مهد الحضارات** كانت أول من وضع حجر الأساس فى فن البناء باكتشاف **قالب الطوب** كوحدة للبناء وأول من وضع أعمدة تكنولوجية علم الانشـــاء الأربعـــة وهى **الكتابة والرسم والرياضيات والهندسة ...** فكانت الاهرامات أول مثل خالد للعمارات العالية فى تاريخ البشرية وأول انتصار لتكنولوجية علم البناء والانشاء فعاشت خمسة آلاف سنة لتشاهد تطور المبانى العالية عبر التاريخ .

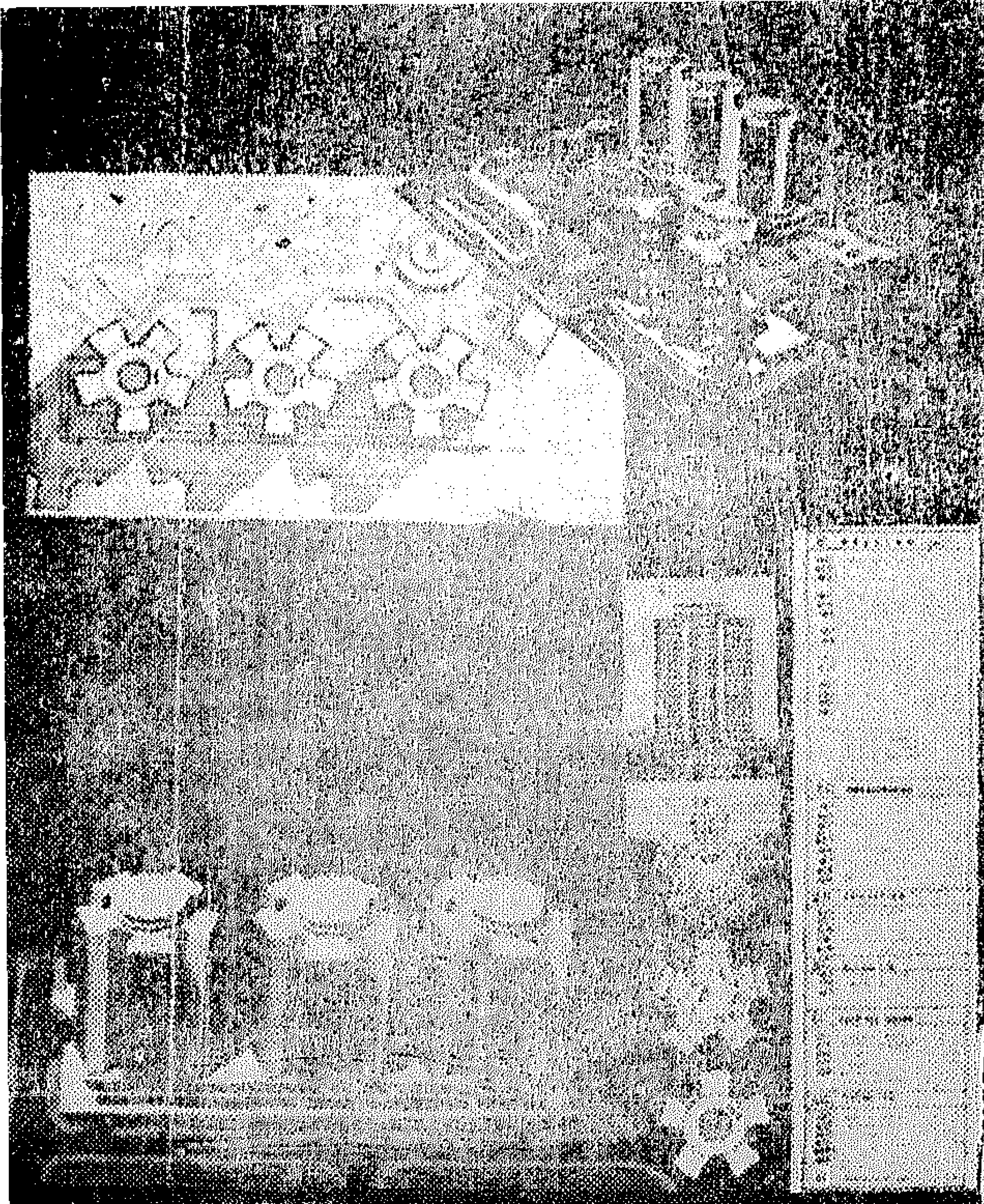
ان محاولات مختلف الحضارات فى التاريخ المعمارى للعالم لاقامة المبانى العالية والتى أطلق عليهـــا **خط السماء التى رسمت ضربات نبض الحضارات .** لم تتوقف ممثلة فى الأبراج العاليـــة السكنية والدينية والتذكارية كبرج بابل وابراج المعابد ، وبرج بيزا ، ومآذن المساجد ، وقبـــاب دور العبادة ، وأهرامات المايا ، وغيرها مما كان يطلق عليها اسم عجائب الدنيا .

● فاذا انتقلنا الى العصر الحـديث نجـد أن العمارات العالية بدأت تداعب خيال المعماريين مع بداية القرن العشرين عندما بدأ المهندسون فى أواخر القرن الماضى فى رسم صورة **عمارة القرن العشرين** فظهرت عدة محاولات سواء فى رسـم صـورة **مدينة الغد** ذات الأهـرامات أو الأبراج السكنية العالية ومساكن المستقبل التى تخيلها هود على شكل الأشجار العـــالية التى تحتل بهيكلها العضـوى أصـغر مسـاحة من الأرض للمحافظة على الطبيعة الخضراء وترتفع طوابقها لتتفرع فى تكوين رأسى يتخلله الهـواء وأشعة الشـــمس أو الحـــدائق الى أعلا كتل المبـــانى وأسـطحها كما تخيلهـــا جاودى أو الأهرامات والأقماع المقلوبة كما تخيلها .





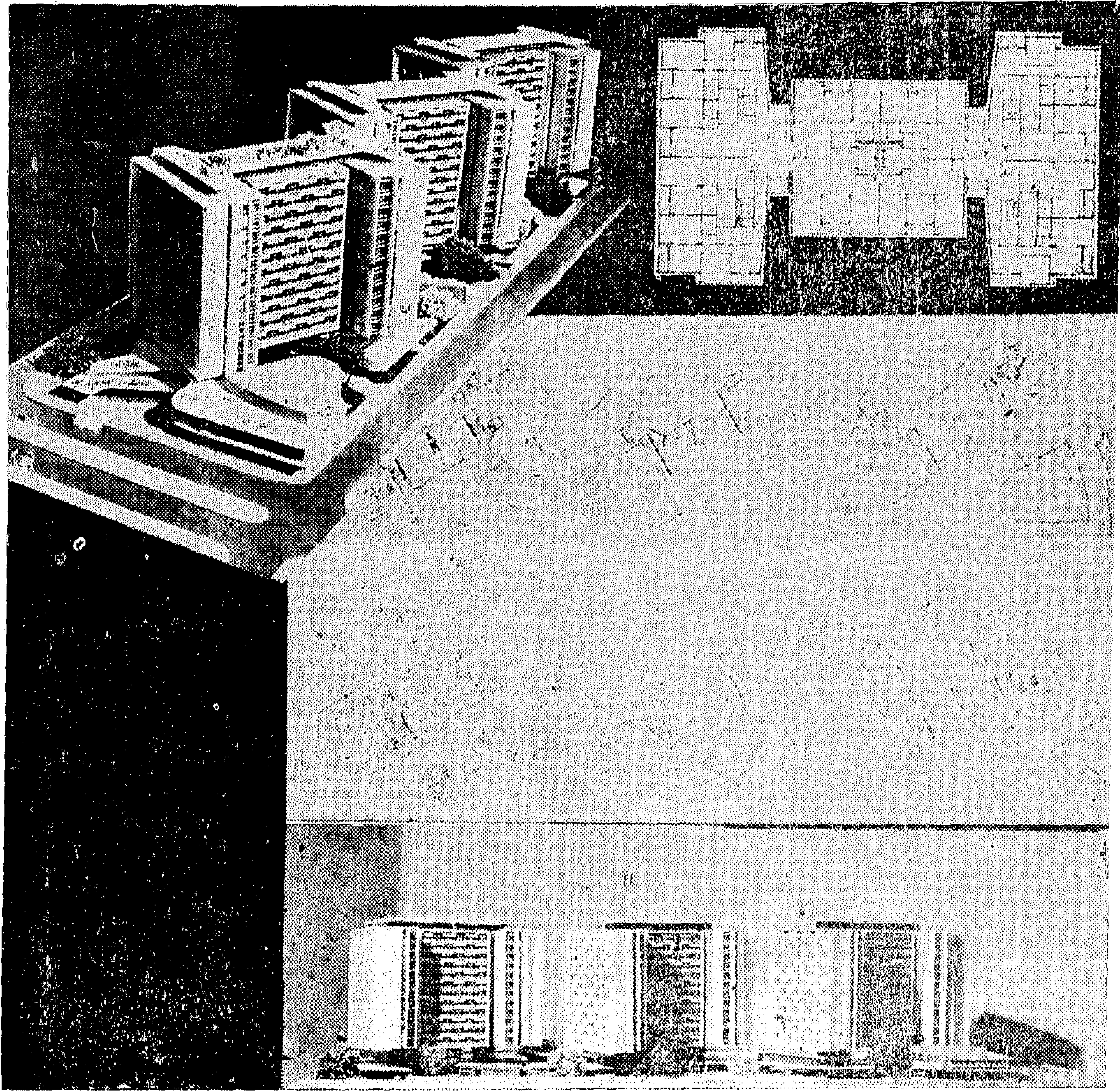
● الاكولوجيا فى تصميم عمارات الفد العالية .. حى سكنى كامل فى عمارة واحدة ٨٥٠٠ ساكن ـ ١٨٠٠ شقة ـ سوق تجارى ـ مكاتب مهنية ـ وحدات علاجية ـ نادى رياضى وسينما ـ حمام سباحة ـ مكتبة ومركز ثقافى ـ دور حضانة ورياض أطفال ومدرسة ابتدائية ـ جراج ٨٠٠ سيارة وأماكن انتظار سيارات ـ حدائق أرضية ومعلقة ـ مساحة أرض الحى الكاملة ٢٥٠٠٠ م٢ .



لقد بقيت تلك المحاولات من ناحية الخروج الى حيز التنفيذ تتخبط بين المعماريين والانشائيين واقتصاديات التعمير فى السنوات الاخيرة التى سبقت الحرب العالمية الثانية ثم ظهرت الثورة التكنولوجية التى ظهرت بعد الحرب فوضعت تكنولوجيا علم الانشاء ومواد البناء من الامكانيات الغيرمحدودة فى يد المصممين مما ساعد على تحقيق أحلامهم بل وسبق خيالهم .

● لقد نجحت التكنولوجيا التى تعتبر شعار العصر الحديث ، نجحت فى تحقيق حلم المعماريين ومخططى المدن فى ظهور المبانى العالية الى حيز الوجود لتحقيق التركيز الرأسى للعمران وترتفع بالكتل السكنية الى أقصى ارتفاع يطاب منهسا لتناطح السحاب .

لقدنجحت انشائيا لتتغلب على جميع العوامل والمؤثرات الجوية والطبيعة من ضغط الرياح وميكانيكية التربة ومقاومة الزلازل . كما حلت مشاكل جميع مرافقها العامة ومختلف شبكات القوى الخاصة بالصرف والتغذية ، كما زودتها بما تحتاج اليه من مواد للبناء وما ارتبط بها من نظريات للانشاء . كما لعبت التكنولوجيا



العمارات العاليــة بمدينة نصر .. ومدينة الاعلام بالدقى ..

دورا لا ينكر فى الانشــــائى وما ارتبط به مـن اقتصاديات فى التكاليف والوقت والقوى العاملة.

المبانى العالية تعتبر انتصارا للتكنولوجيا :

ومع ذلك فكلما سجلت انتصارات جديدة قوبلت من ناحية أخرى بهجوم متصاعد فى أكثر من المجالات الفنية والندوات الهندسية . وصفها بعض النقـــاد بأنها مصـــانع للتفريخ البشرى ووصفها البعض الآخر بأبراج حمام الاسكان .

وفى وصف ثالث معتقلات المجتمع الاسكانى الحديث ، لمجتمــع الاســكانى أعلب . حتى مشروعات تعمير الخرائب فى وسط المدن الكبيرة والتى وجد أن المبانى العالية هى الحل الوحيد لتعميرها فقد أطلق عليهـا البعض اسم خرائب الاسكان الحديثة .

لقد اثبتت الأبحاث الخاصة بتلوث البيئة فى المدن أن التركيز العمرانى الرأسى .. الممثل فى المبانى العالية من الأسباب المباشرة فى ارتفـاع نســبة التلوث فى عناصره المعروفة كالهـواء والصوت والرائحة والغبار ، بل لقد أضاف اليها عناصر جديدة لم تكن موجودة من قبل كالتلوث الاجتماعى والاقتصادى والزمنى .

لقد نسبت تلك العيوب جميعها الى علاقـة المبانى العالية بتصاعد التركيز العمرانى وما تبعه من زيادة الكثافة السكانية .

هناك اتهــام آخــر وجــه الى التكنولوجيا ومسـئوليتها فيما وجه الى المبـانى العالية من انتقادات وهو علاقتها باقتصاديات التعمير من حيث استغلالها لتحويل المبانى العالية الى سلعة تجـارية حيث يوجه الانتاج لصـــالح الكسب

واستغلال الحاجة الاضطرارية — أي أن يتقبل المستهلك ما يفرضه المنتج ، حيث الكمية تتحدى الجودة . أى استغلال التكنولوجيا للهبوط بالمستوى الانسانى بدلا من الارتفاع به .

● لقد حلت تلك المبانى العالية أو الكتل العمرانية المركزة مشاكل الاسكان والتعمير من زاوية واحدة — **زاوية توفير المأوى (المأوى الاضطرارى لمواجهة الانفجار السكانى)** حتى أنها تعرضت للكساد عندما وجد سكانها منفذا للهروب الى ما هو أكثر صلاحية ، مما أدى الى ظهور أنواع جديدة من التأمين العقارى وهو ما أطلق عليه فى كثير من البلاد التأمين على الشقق الخالية .

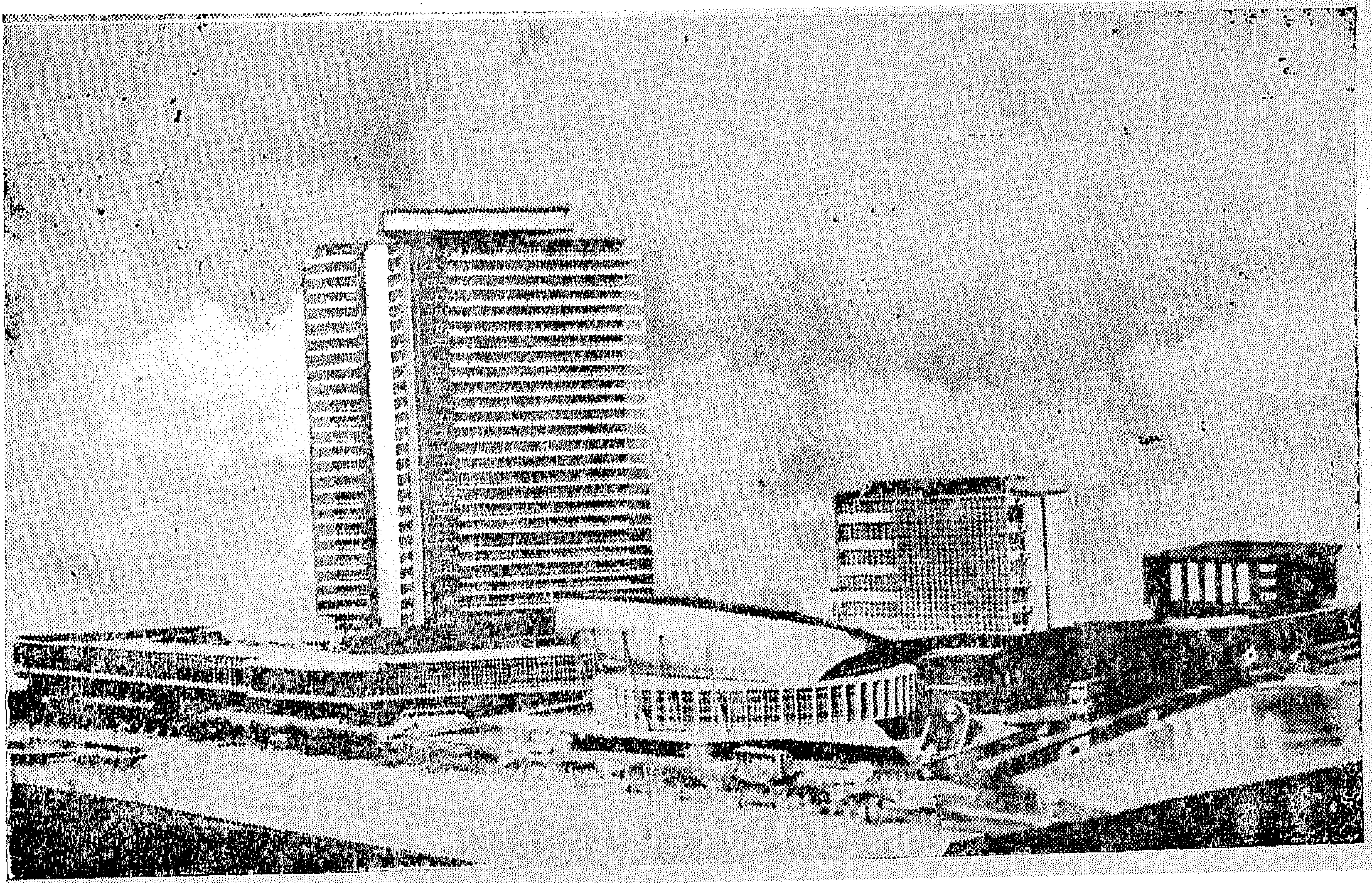
لقد فشلت العمارات العالية — التى ولدت عوامل انحلالها مع عناصر انشائها . فشلت فى تحقيق الغرض Function أو الدور الاجتماعى الحضارى الذى عليها أن تقوم به ليضمن بقاءها لعوامل الانحلال .

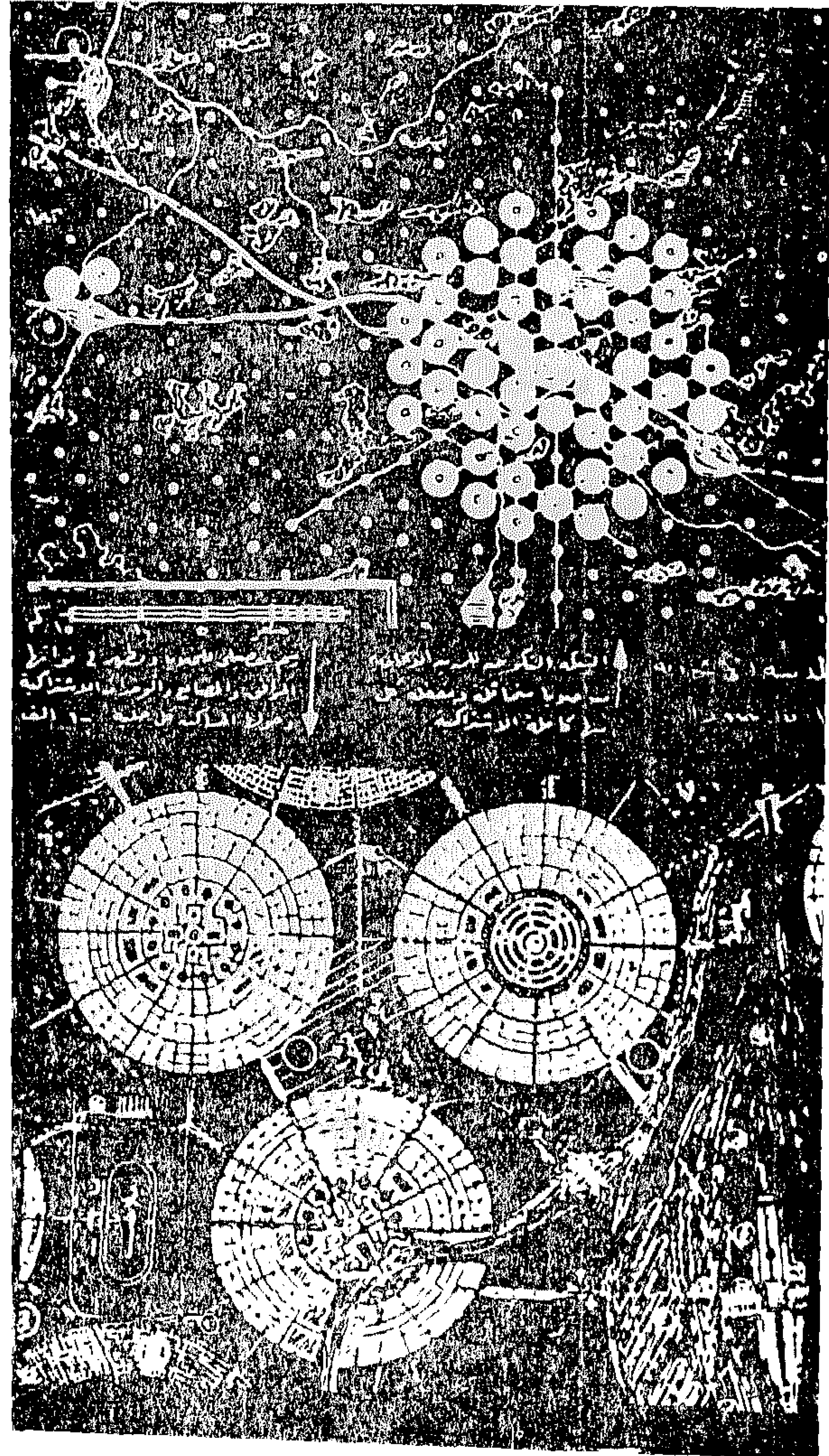
وليس هناك سبيل لتحقيق ذلك الغرض الا بواسطة الأكولوجيا Ecology أو عنصر الحياة **والبقاء لوحدة السكن فى اطار المجتمع الانسانى العضوى وعلاقات ترابطه الاجتماعى والاقتصادى ومختلف نشاطه العملية والثقافية والتعليمية والتجارية والرياضية والترفيهية .**

● **فالأكولوجيا الانسانية هى علم دراسة العلاقات الانسانية فى المجتمع وتفهم مشاكل المواطنين الفرد ومجتمعه السكانى كعناصر بيولوجية تتغير وتتطور بعمق أو مدى تأثره بالبيئة ومدى تأثيره على البيئة نفسها تبعا لاختلاف المؤثرات الطبيعية والبيولوجية والحضارية .**

فبدراسة تلك المشاكل يمكن تخطيط المجتمع الصحى المتكامل وتخطيط التعمير الذى يأوى ذلك المجتمع ومطالبه . وهى التى ستحدد الغرض الفعلى الذى سيحدد بدوره تصميم المبانى العالية ويخلصها مما وقعت فيه من أخطاء وما لحقها من عيوب .

التخطيط الرأسى لحى ماسبيرو السياحى — مشروع تخطيط وتصميم منطقة أبو العلا / القاهرة الواقعة على كورنيش النيل . يجمع التخطيط مدينة سياحية كاملة الخدمات من فندق ١١٠٠ غرفة وقرية سياحية واسكان دبلوماسى ومتحف للاستعلامات والحضارة .. ومحطة مواصلات للنقل السياحى البرى والجوى والبحرى .





● ان فى مقـدمة المشـاكل التى كشـفتها الاكولوجيا فى المجتمع الاسكانى المركز أو سكان المساكن العالية فى المـدن الكبيرة ذات الكثافة السـكانية العـالية كان تلوث البيئة أو الزيادة المضطردة فى نسـبة التلوث التى شـملت تلوث الهـواء الراكد بين الكتل السـكنية المقفلـة ، بالغازات والغاز والروائح ، والتلوث بالصـوت والضوضـاء والاشعاعات هـذا بجانب العناصر العصرية للتلوث التى ظهرت حديثا كالتلـوث الاجتمـاعى والاقتصـادى والزمنى (الوقت الضائع) وتلوث الأمن الناتج من أخطار المرور والكثافة السكانية والتى أطلق عليهـا أمـراض التعمـير والاسـكان Ills or urbanization. لقد حلت الاكولوجيا مشـاكل البيئة وتلوثهـا وانحـلالها الاجتماعى والاقتصادى بالعـودة الى تكوين المجتمع العضـوى الصحى المتمـاسك والمتكامل . ان ذلك التكوين هو الذى سيضع

الحى السكنى المتكامل كخلية سكنية فى تصميم مدن الغد . . نظـرية جـديدة لتوسيع المدينة بطريقة التكاثر العضـوى للخلايا . .

برنامج التخطيط ابتـداء من الخلية أو الوحـدة السكنية الى المجمـوعة السـكنية أو المجتمـع المتكامل الى تخطيط المدينة باكملهـا ـ فذلك البرنامج هو الذى يحدد الفرض .

والفرض سيحدد شكل المبانى العالية نفسها وحجمهـا وتوزيعهـا ومحتوياتها **سيكون المبنى صحيا من ناحية تأدية الفرض لمجتمع صحى .**

فان كانت المبانى العالية قد فشلت فى تحقيق غرضها فالعيب لا يكمن فى انها مبان عالية ، بل لأنها بنيت **لتأوى السكان كأفراد لا كمجتمـع لا تنحصر مطالبه فى المأوى ـ** عملت على تفتيت المجتمع العضـوى بدلا من تحقيـق كيـانه الانسانى .

● من المفروض أن الارتفاع بالمبانى من اهم العوامل على التغلب على الكثير من عنـاصر التلوث حيث يسهل تعرض المساكن لأشـعة الشمس والهواء النقى وارتفـاع الوحـدات السـكنية عن مسـتويات التـلوث بالحشرات والذباب والباعوض والغبـار . كما تساعد على حركة الهواء خلال المساكن والمجموعات السكنية والتى تحدد الاكولوجيا أشكالها التى تحقق تلك الأغراض .

فكيف يمكن الجمع بين الاكولوجيا والتلوث فى حل مشكلة الاسكان المركز والتعمـير الرأسى أو العمارات العالية لتحتل مكانها فى التعمـير كعنصر مميز من عناصر الحضارة العمرانية لعالم الغد ؟

سـيبدأ البرنامج بتكوين المجتمع السـكنى Community لقد حددت أبحاث اقتصاديات المجتمع العمرانى الحد الأدنى لمثل تلك المجموعة السـكنية المتكاملة بعـدد يتراوح بين ٨٥٠٠ ، ١٠٠٠٠ ساكن يضمها ١٥٠٠ الى ٢٩٩٩ وحدة سكنية كما ان الحد الأدنى لمساحة الأرض اللازمة لها ٥ر٣ ـ ٣ هكتار .

ومن دراسات العلاقة بين الخـدمات العامة لسكان المدينة أو عدد السكان المبينة فى الجدول التـالى نرى ان الخـدمات اللازمة للمجمـوعة السكنية المتكاملة كالآتى :

(ا) الخدمات التعليمية والتربورية

١ دار للحضانة

١ روضة اطفال

١ مدرسة ابتدائية

(ب) الخدمات الصحية

١ مركز الولادة ورعاية الطفل

٤ عيادات طبية خاصة

١ مركز اسعاف وصيدلة خاصة

(جـ) الخدمات المهنية والادارية

٥٠ وحدة مكاتب

١٠ ورشة وستوديو

(د) الخدمات الثقافية

١ مركز ثقافى

١ مكتبة المجتمع

(هـ) الخدمات الترفيهية والرياضية

١ نادى اجتماعى ورياضى

١ جمنائيوم وملاعب

١ حمام للسباحة

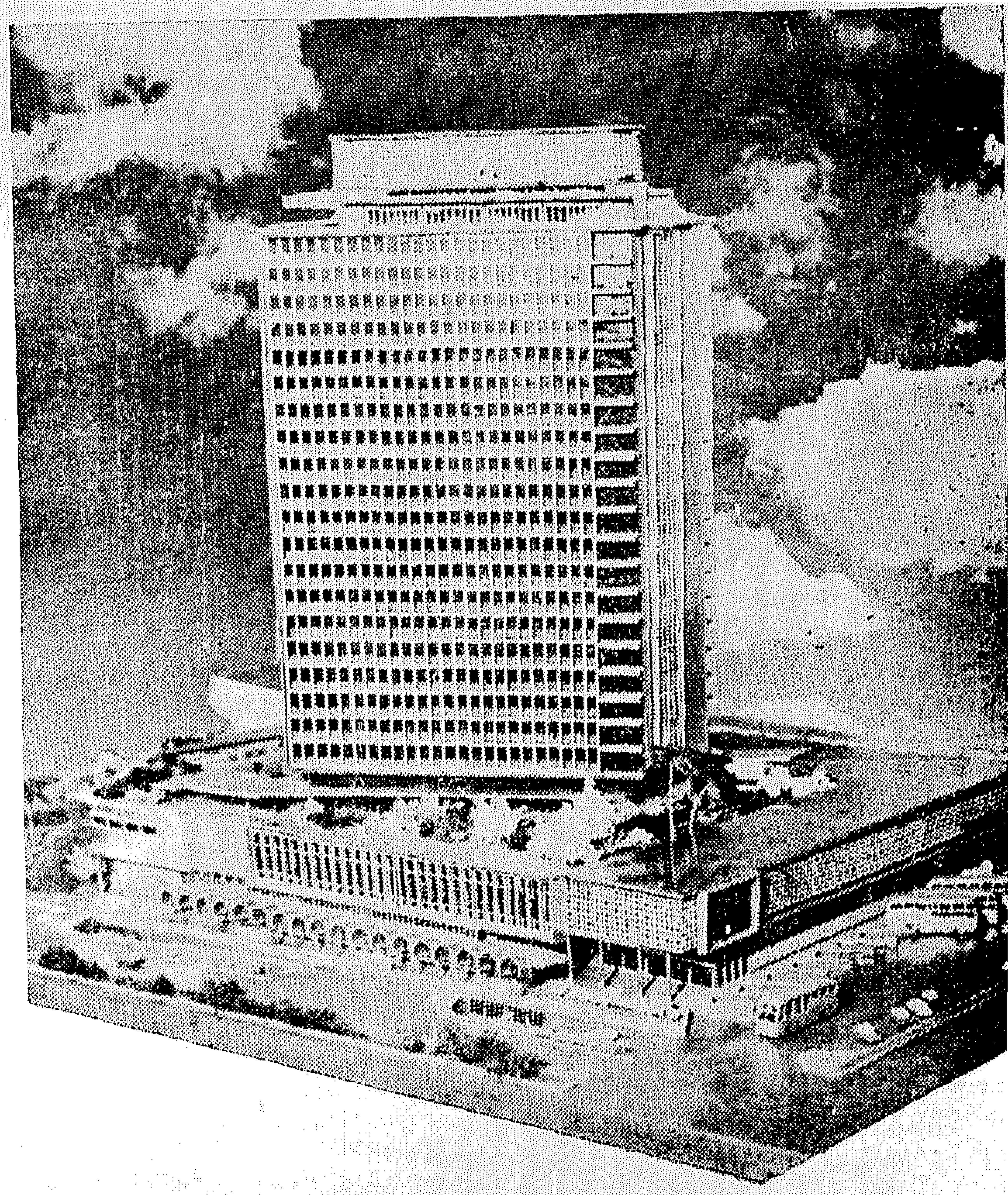
١ مسرح وسينما النادى

حدائق للرياضة والترفيه

(و) الخدمات التجارية والتموينية

سوق تجارى عام ٥٠ وحدة

سوبر ماركت ومجمع تموينى



المبانى العالية انتصار للتكنولوجيا . . . مجموعة سكنية عضوية التكوين متكاملة تجمع جميع الخدمات اللازمة لسكانها ــ مشروع الاسكان الدبلوماسى بالزمالك ــ بالقاهرة .

مجمع تجارى
كافتريا ومطعم ومقهى
مغسل عمومى
مركز للصيانة ٦ وحدات

(ز) الخدمات الادارية

مكتب للبريد والتليفون
مركز للأمن
مكاتب ادارات حكومية ٤ وحدات

(ح) خدمات النقل

محطة للنقل العام
محطة خدمات للسيارات
جراج عمومى وانتظار سيارات ٨٠٠ سيارة

كما تحتوى المجموعة مختبراً عام مجهز بالخدمات الطبية والتموينية

● ان هـذا البرنامج العمرانى فى اطار الاكلوجيا سيضع شبكة الفرض Patern of functions ذات التكوين العضوى والتى سيحدد بدورها التكوين المعمارى وشكل المبانى العالية وطريقة استغلالها فى حل مشكلة التعمير المركز .

● لما كانت علاقة ما قمت به من دراسات وأبحاث ترجع الى ربع قرن تقريبا حيث قمت بوضع الأبحاث الاولى فى علاقة العمارات العالية فى التخطيط للاسكان والاشتراكية التعاونية فى المؤتمر الاسكانى بجانب الدراسات التى وضعت لهذه الامم فى تخطيط أكثر من من مدينة من المدن التى قمت بها سواء فى مصر أو الخارج .

فسأقدم بعض النماذج التى للمجموعات السكنية المقترحة تتلخص فى معادلة التكوين المعمارى :

١ ـ احضار الطبيعة بمزاياها المتعددة من هواء نقى وخضرة وماء الى داخل المجموعة السكنية بدلا من الخروج بالمساكن من وسط المدينة المقفل الى محيطها الخارجى وهو ما نادى به البعض من العودة الى الطبيعة .

٢ ـ تعريض المساكن ومسطحات واجهتها وفتحاتها الى أقصى حد من الجو الطبيعى الخارجى وأشعة الشمس .

٣ ـ عدم اعتراض الكتل العمرانية المتراصة والمتداخلة لتحريك التيارات الهوائية خلال المبانى والطرقات سواء فى المبنى أو فى المدينة باكملها مع فتح المجال أمام أشعة الشمس والضوء الطبيعى لتصل الى الطرقات والادوار السفلى من المبانى مع مكافحة ركود الهواء فيها وفى الجيوب المقفلة بين الكتل السكنية .

٤ ـ تحديد مسافات الانتقال Walking Distance بالنسبة لكل فرد من أفراد المجتمع ابتداء من المولود ومسافة الانتقال لمكان حضانته ، والطفل وروضته ، والطالب ومدرسته والفرد ومكان عمله ، وكل فرد فى المجتمع ومكان نشاطاته المختلفة سواء لتأمين صحته اواستغلال وقت فراغه فى اماكن ترفيهه ورياضته .

ان التركيز الاسكانى فى المدينة الكبيرة كان من اكبر العوامل فى اطالة المسافات . . مسافات الانتقال وقد تمتع بتلك الاطالة زيادة الحركة والانتقال ووسائله الآلية التى كانت من العوامل الأساسية العالة فى ظهور العديد من ملوثات البيئة سواء من تلوث الهواء أو الضوضاء أو الرائحة بجانب الأمن على الحياة أو ما اطلق عليه امراض أخطار المرور من اصابات وحوادث ـ لقد حلت الوحدة السكنة المتكاملة مشكلة مسافات الانتقال بحيث جمعتها داخل حدود المبنى وأمكانها تحيق مسافات انتقال اقل بكثير مما حددته نظريات تخطيط المدن .

لقد تغلبت نظرية مسافات الانتقال المثالية المجموعة السكنية على مرض من أهم أمراض تلوث البيئة فى المدن الكبيرة وفى المجتمع المعاصر وهى مشكلة « تلوث الوقت » أو الوقت الضائع الذى يقضيه الساكن بين مختلف نشاطاته مما وصل الى ٢ ٪ من وقت عمله على حساب وقت راحته وفراغه مما كان من أهم الأسباب المباشرة فى تفكك العلاقات الاجتماعية فى المجتمع الانسانى للاسكان .

٥ ـ رفع مستوى اقتصاديات المجتمع وعلاقاته الانسانية بواسطة تأمين الخدمات الصحية والثقافية والاقتصادية والتعاونية أى بنقلها اليه بدلا من انتقاله اليها فى مختلف أحياء المدينة .

ان تلك الخلية السكنية العضوية التكوين — أو الحى السكنى المتكامل ذو الاستقلال العمرانى ان تكون حلا لمشكلة التعمير الرأسى فى مشروعات الاسكان الجديدة أو مشروعات تعمير الخرائب Slum Cleearance فى المدن لكبيرة القائمة التى تتعرض احياؤها الشعبية القديمة الى الانحلال العمرانى وما يطلق عليه سرطان المدن الكبيرة ، بل ستضع تلك المجموعات السكنية او الخلايا السكنية العضوية التكوين أسسا جديدة لمدينة الغد ذات التكوين العضوى حيث ستصبح كل خلية سكنية أو حى سكنى متكامل عدد سكانه ٨٥٠٠ — ١٠٠٠٠ ساكن عضوا فى اكبر خلية مكونة من ستة خلايا مجموع سكانها ٥٠٠٠٠ ساكن .

كما تشترك كل ستة مجموعات من تلك الخلايا فى خلية أكبر عدد سكانه ٣٠٠٠٠٠ ساكن ويكون لكل خلية مجمعة من ستة خلايا مركز ادارى على مستوى المنطقة السكنية .

وهكذا تتسع المدينة تبعا لنظرية التكاثر العضوى فتتجمع كل ستة مناطق لتكون مدينة كبيرة سعها ١٫٨٠٠٫٠٠٠ الى مليونى ساكن .

الآن وقد أثبتت المبانى العالية وجودها كعنصر فعال من عناصر التعمير الحضارى سواء فى الاسكان بالنسبة للجتمع الاسكانى المركز أو فى تخطيط المدن بالنسبة للتعمير الرأسى يتردد السؤال عن المبانى العالية بالنسبة لمصر ومدى صلاحيتها من ناحية ملاءمتها الجوية والطبيعية وطبيعة الأرض أو الظروف الاقتصادية والاجتماعية .. هل نحن فى حاجة اليها . وهل هى ضرورية ؟

الرد على هذا السؤال .. هو ان المبانى العالية بالنسبة لمصر أو للشرق عامة .. أو لأى بلد فى العالم ارتبط بالحضارة العالمية المشتركة أصبحت ضرورة لحل أكثر من مشكلة فى مقدمتها مشكلة الانفجار السكانى وأثره فى تضخم حجم المدن واتساعها غير المحدود وما تبعه من انفجار عمرانى .

فالقاهرة مثلا زاد عدد سكانها من أربعمائة ألف ساكن الى مليون ساكن خلال مائة عام . ثم انتقل من مليون الى مليونين خلال ربع قرن ثم وصل الى ستة ملايين خلال ربع قرن آخر وسيصل الى ١٢ مليون خلال ربع قرن آخر (القاهرة الكبرى) مع ما يدخل فى الاعتبار من اجراءات وتخفيض الانفجار اجتماعيا واقتصاديا وعمرانيا .

ان اتساع العمران وما يتبعه من التهام المدن للأراضى الزراعية الخضراء فى الوقت الذى تسير فيه زيادة الأرض الزراعية فى اتجاه مضاد أو غير متوازن مع زيادة السكان من اهم العوامل فى وقف الامتداد الأفقى للمدن والاتجاه الى الامتداد الراسى اى البناء العالى والأحياء المركزة .

كما ان اقتصاديات التعمير ـ المبانى العالية لمواجهة الانفجار السكانى سترجح كفة المبانى العالية من ناحية الاقتصاد فى التكاليف والخدمات معرفع المستوى من ناحية وماتتميز به تكنولوجية الاسكان المركز والتعمير الرأسى من ناحية سرعة البناء والانجاز حتى يلاحق الانتاج العمرانى فى وحدات السكن سرعة الانتاج البشرى المتصاعد واحتياجاته المتزايدة للسكن والخدمات والمرافق .

ان وسائل النقل من سيارات وطائرات ومنوريل وصواريخ ووسائل الاعلام من راديو وتليفزيون واقمار صناعية اصبحت جميعها من وسائل مقومات الحضارة الحديثة لا يعبر أى منها عن طابع محلى أو قومى أو اقليمى كما كان الحال فى حضارات الماضى المنعزلة وطرازها القومية المميزة أصبحت تعبر عن طابع عالمى له حضارة مترابطة ومشتركة ، ان جميع مقومات الحضارة أخذت ذلك الاتجاه العالمى المشترك .
فهناك الثقافة العالمية والأدب العالمى .. وأدوات الملبس العالمية بل ومواد لتغذية العالمية .. حتى وسائل الدمار أو أسلحة الحرب أصبح لها الطابع العالمى المشترك وأصبح لا ينتجها شعب معين لنفسه فقط .

كذلك العمارة .. وهى أيضا عنصر أساسى أشكالها وارتفاعها وطابعهامن العوامل الاكولوجية والتكنولوجية ستخضع لذلك الناموس التكوينى للحضارة العالمية التى ترتكز على الأبحاث المشتركة والانتاج المشترك والتى تعتمد على البقاء للأصلح .. أو الأصلح لخدمة الجميع .

فالمبانى العالية والأبراج السكنية اذا أثبتت صلاحيتها كوسيلة للاسكان والتعمير للجتمع العالمى فمعنى ذلك أنها ستكون عالمية تحمل طابع العصر ويتحدد دورها فى رسم خط السماء للحضارة المعاصرة فى تاريخ العمارة .

ECOLOGY AND THE TALL BUILDING

by : Dr. Sayed Karim

Osc. Architect E.T.H. U.N. Consultant

?Technology, from which the Modern Era acquired its title "Age of Technology', has succeeded in realizing the dreams of architects and town planners. It, not only solved the problem of urban centralization, and made it possible to raise buildings to any height to form the skyline of the city of tomorrow, but it also succeeded constructionally in overcoming all the natural & physical statical problems (wind pressure, soil mechanics, earthquakes, constructional statics, etc..) Moreover, it successfully solved the ever growing problems connected with both the cost and improvement of public utilities and services. It also supplied buildings with new and improved industrial building materials together with their new applied theories of construction, in addition to the advantage of rapidity in erection. Unquestionably, therefore, the tall building is a triumph for technology in the building science.

The tall building, whose destructive elements emerged in conjunction with its creation, has failed in fulfilling its basic function, i.e. its cultural and social role which guarantees its existence and prevents its deterioration. It is only through Ecology that the basic function of the tall building can be achieved. The basic function of ecology is to avert the destructive environmental elements. This consists of all that leads to environmenal pollution varying from chemical and bilogical to social and economic pollution - ills of ubranization.

The housing project as a tall building based on human ecology as a frame of reference will determine the network of the function with its organic formation with its organic formation which in turn will determine the architectural composition and the shape of the tall building and the way it can be properly exploited to solve the problems of centralized housing. In other words, an organic solution for an organic society, or the organic formation of the tall building.

This analysis is followed by various examples, derived from my former researches and studies in the field of urbanization in Egypt and abroad, all of which show the influence of taking ecology into consideration in vertical housing in the form of tall buildings in housing schemes and town planning.

* * *

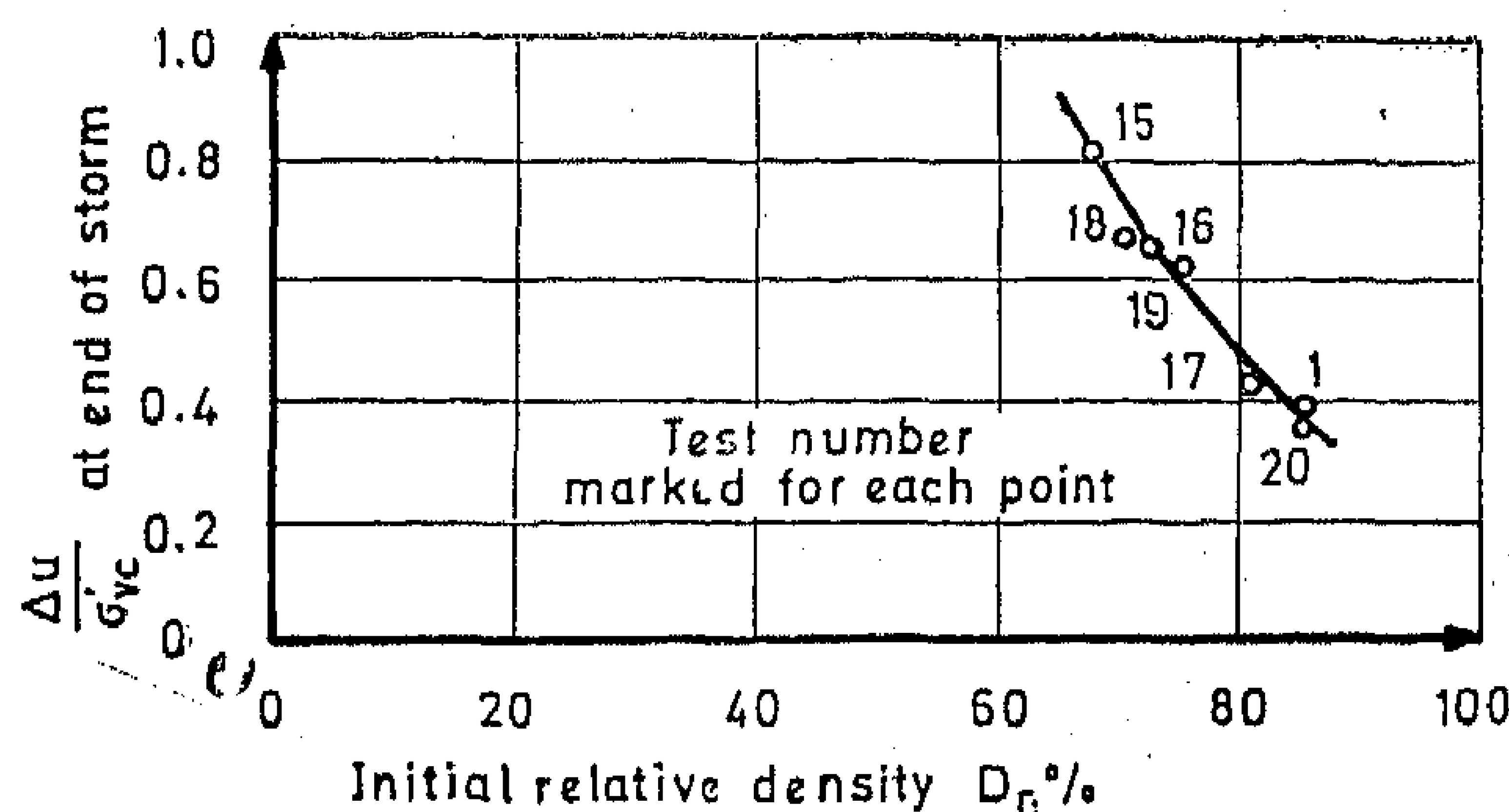


Fig. 7 Normalized "pore pressure" $\Delta u/\sigma'_{vc}$ at the end of the first and second application of the storm loads versus initial relative density.

"pore pressure" due to the second loading of the storm is 16%, 46%, and 69%. This corresponds to initial relative densities of 71,17%, 75.60%, and 85.50% respectively. This leads to the conclusion that the resistance of sand to repeated storms increases with its density on condition that there are quiet periods between the storms of sufficient length to dissipate the excess "pore pressure" developed in the sand.

SUMMARY AND CONCLUSIONS

Eight constant-volume cyclic simple shear tests were conducted on medium dense and dense samples of clean sand. The samples were consolidated under a vertical pressure σ'_{vc} = 2.5 kg/cm². A series of increasing horizontal cyclic shear stresses were applied to the samples to simulate the loads transmitted to a sand foundation supporting a gravity structure subjected to an arbitrary one-year storm in the North Sea area. Comparative tests were carried out on dry and saturated samples of sand. The effect of both density of sand and repetition of storms on the cyclic "pore pressure" have been invesitigated. On the basis of test results obtained, the following conclusions are reached:

1 — Clean sand has the same behaviour in constant-volume cyclic simple shear and the number of stress cycles.

2 — The cyclic "pore pressure" increases with both the cyclic shear stress level and the number of stress cycles.

3 — The rate of increase in cyclic "pore pressure" increases with the cyclic shear stress level,

4 — At any stage of the simulated storm the cyclic "pore pressure" decreases as the density of sand increases.

5 — On condition that the excess "pore pressure" can dissipate during the quiet periods between the storms, it has been found that the cyclic "pore pressure" decreases markedly due to repetition of storms. Also, the resistance to repeated storms increases with the density of the sand.

ACKNOWLEDGEMENTS

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Cyclic shear stress level τ_h/σ'_{vc}

0.04 0.06 0.08 0.10 0.13 0.17 0.19

$\frac{\Delta u}{\sigma'_{vc}}$

0.867

2.355

$+\varepsilon_h$% $-\varepsilon_h$%

Number of stress cycles N

Fig. 5 Constant-volume cyclic simple shear test results - Medium dense sand; test no. 12.

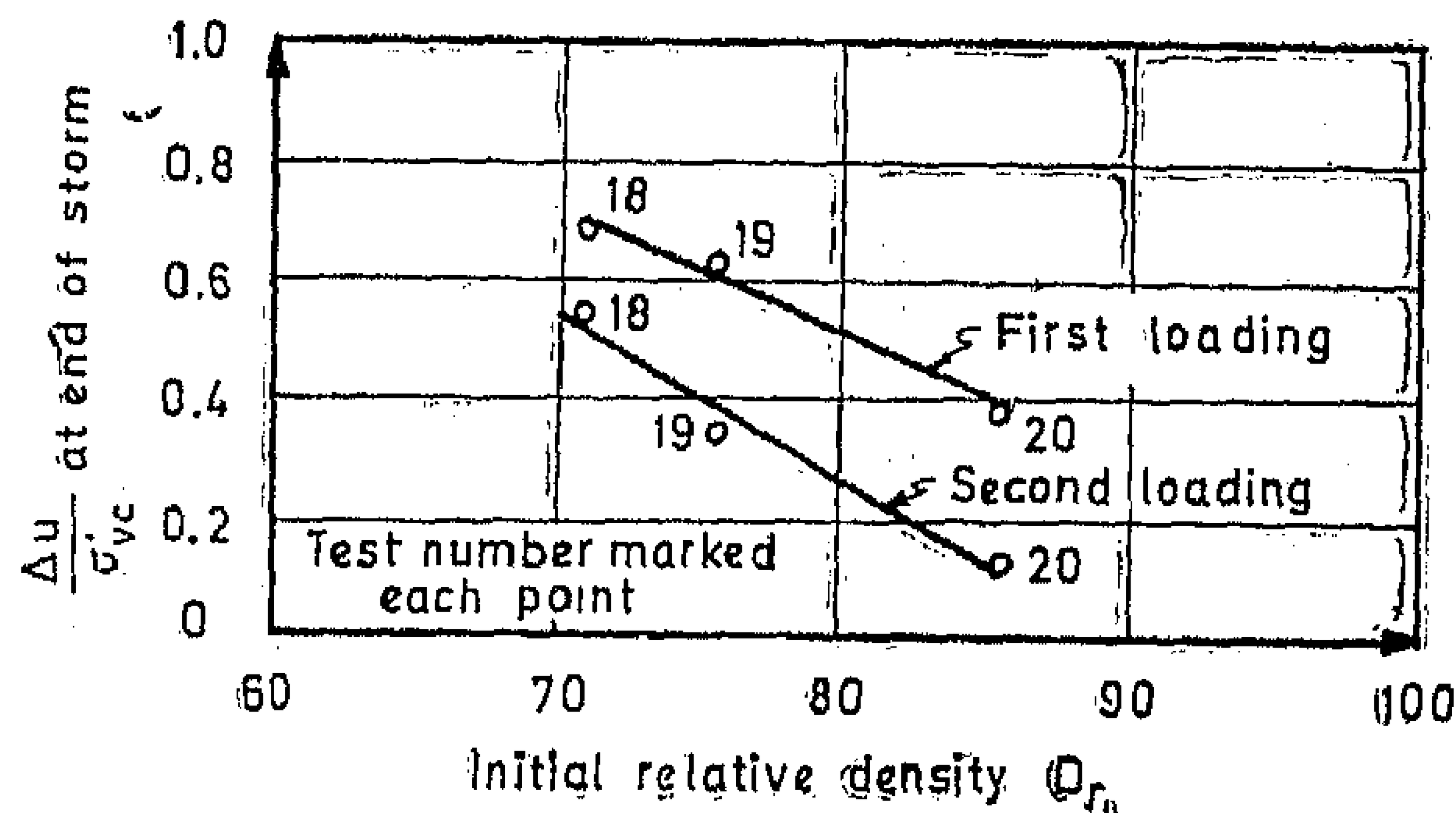


Fig. 6 Ecect of density on the cyclic "pore pressure" developed in sand at the end of the storm.

2 — Shearing resistance of sand foundation to repeated sea storms

The normalized "pore pressure" $\Delta u/\sigma'_{vc}$ developed in samples 18. 19, and 20 at the end of the first and second applications of simulated storm loads were plotted versus the initial relative density, as shown in Fig. 7. It is obvious that the cyclic "pore pressure" is less in the second application of the storm than in the first one, and it decreases as the density of the sand increases. The percentage decrease in cyclic

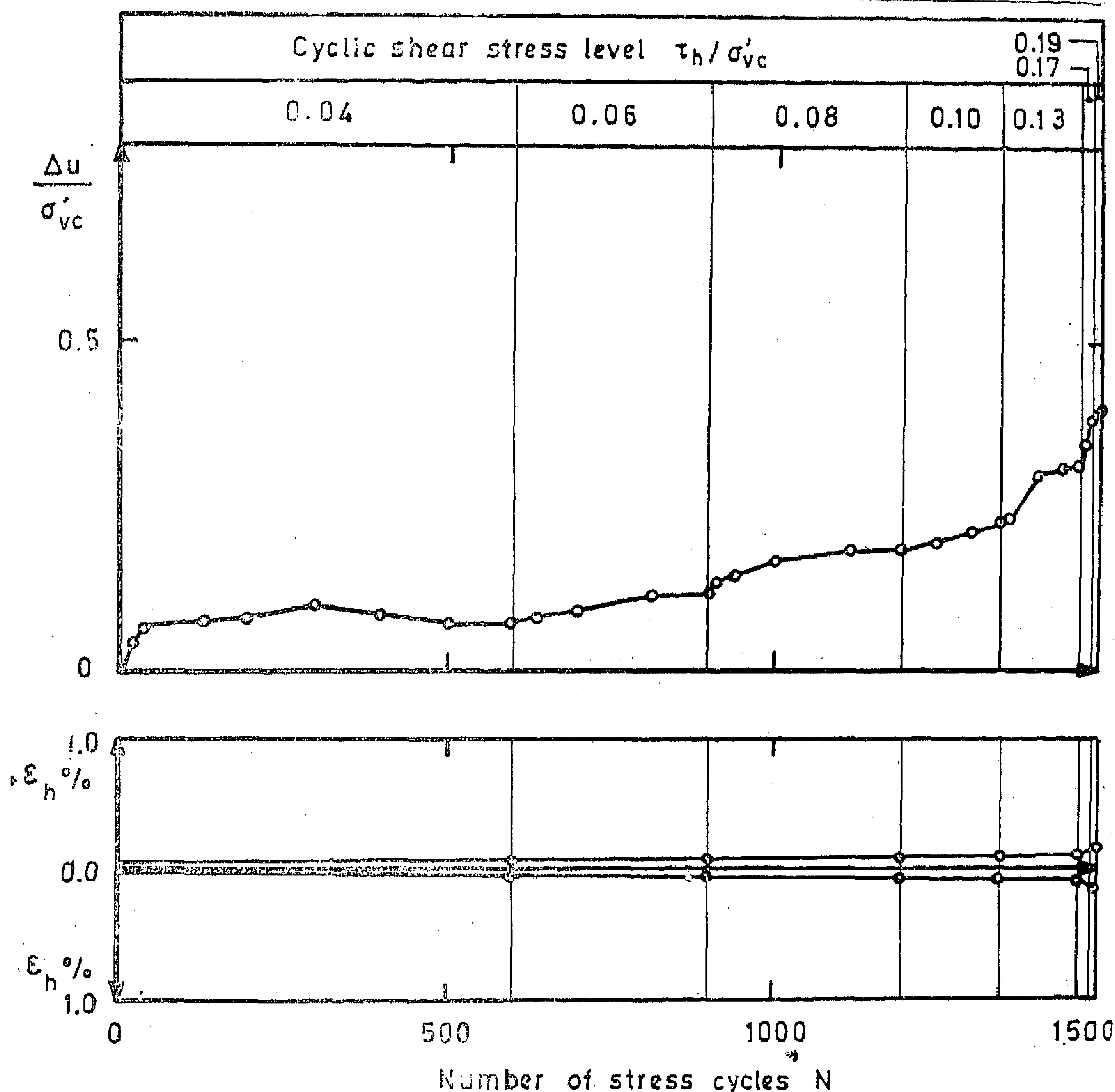


Fig. 4 Constant-volume cyclic simple shear test results - Dense sand; test no. 1.

greater than 80% were able to resist the loads of the storm without showing any sign of liquefaction. The normalized "pore pressure" $\Delta u/\sigma'_{vc}$ developed in the samples at the end of the storm were plotted versus the initial relative density, as shown in Fig. 6. The figure shows a steep rate of decrease in cyclic "pore pressure" within a small range of relative density.

On the basis of the test results, it can be concluded that, if no "drainage" is allowed to occur, the relative density of 80% can be considered as the lower limit of the safe density for this sand with this particular simulated storm loading pattern.

Table 2

Relative densities of the tested samples.

Test no.	Relative density Dr% First loading		Second loading
	Before consolidation	After consolidation	
(1)	(2)	(3)	(4)
1	85.71	88.83	—
12	54.28	57.92	—
15	68.05	73.51	—
16	72.21	78.44	—
17	80.26	85.45	—
18	71.17	75.25	77.25
19	75.60	79.12	79.12
20	85.50	88.31	88.31

tions were made for both the resistance of the reinforced rubber membrane and the play in the vertical loading system of the apparatus.

EXPERIMENTAL PROGRAMME

The sequence of cyclic shear stresses applied to the samples and the correspon-ding number of stress cycles followed the load pattern of an arbitrary chosen one-year sea storm as given in Table 1. Altogether eight samples were tested. The hypothetical storm loads were applied once on the samples of test nos 1, 12, 15, 16, and 17. On the other hand, in test nos 18, 19 and 20, the samples were subjected to the loads of two equal hypothetical storms, with "drainage" allowed at the end of the first storm. The "drainage" was achieved by restoring the vertical stress to its initial value, σ'_{vc} = 2.5 kg/cm^2. The increase in relative densities due to "drainage" was less than 2%, as can be seen from columns 3 and 4 of Table 2. Tests 18 to 20 were carried out to simulate the field loading conditions in which the cyclic "pore pressure" developed in the sand foundation dissipates at the end of a sea storm during the relatively quiet periods between the storms.

Table 1.

Cyclic load pattern of the simulated storm

Number of stress cycles N	Cyclic shear stress level τ_h/σ'_{vc}
600	0.04
300	0.06
300	0.08
150	0.10
120	0.13
20	0.17
10	0.19

DISCUSSION OF TEST RESULTS

The results of the tests are plotted to show the change in both the normalized "pore pressur" $\Delta u/\sigma'_{vc}$ and the horizontal shear strain ε_h with the number of stress cycles N. Two typical test results are shown in Figs. 4 and 5. They represent test no. 1 on dense sand and test no. 12 on medium dense sand respectively. The test data showed that, at a given density. the cyclic "pore pressure" increases with both the cyclic shear stress level and the number of stress cycles. Also, the rate of increase in "pore pressure" increases with the cyclic shear stress level. It is noteworthy to mention that under low cyclic shear stress levels, $\tau_h/\sigma'_{vc} \leq 0.08$, an increase in "pore pressure" takes place during the application of the first few cycles. Thereafter. the "pore pressure" increases very slightly with the number of stress cycles. The test results will be discussed in the following.

1 — **Effect of density on cyclic "pore pressure"**

The test results showed that samples with relative densities less than about 70%, as in test nos 12 and 15, failed at intermediate stages of the simulated storm because of liquefaction. In the present study, liquefaction refers to the condition in which large strains start to take place in the sample under an applied cyclic shear stress. It has been observed that the less the density of the sample, the earlier the stage of the storm at which the sand reached liquefaction. The sample in test no. 12 reached liquefaction at a cyclic shear stress level σ'_{vc} = 0.08. after applying only 110 stress cycles under this stress level. In test no. 15, where the density of the sample was somewhat higher, the sample could withstand a part of the storm up to τ_h/σ'_{vc} = 0.13. The number of stress cycles which caused liquefaction at this cyclic shear stress level was 80 cycles. The samples in test nos 16, 18, and 19 were found to reach liquefaction just at the end of the storm. The initial relative densities of these samples were 72.21 %, 71.17%, and 75.60% respectively. On the other hand, samples with initial relative densities

The shear strength of clean sand is caused by the interlocking of the grains. Hence, it is to be expected that there will be no difference in the shearing resistance of sand whether it is totally saturated or completely dry. As illustrated by Fig. 3, the test data show clearly that there is no appreciable difference in the behaviour of dry and saturated sands under cyclic simple shear loading. Similar results were also obtained from previous constant volume static simple shear tests on the same sand. The same can also been observed from the results of constant-volume direct shear tests on sand given by Feda [2]. Building in samples of dry sand is easier and less time consuming than with totally saturated ones. Therefore, the tests described herein were carried out on dry samples of clean sand.

The sand used was obtained from the Frigg Field in the North Sea. It was uniform, medium to fine, with grain diameters varying from 0.06 mm to 0.59 mm; D_{10} = 0.15 mm and D_{50} = 0.20 mm. The maximum and minimum void ratios were 0.835 and 0.450 respectively. The coefficient of permeability, k, of a 75% relative density sample was 3 x 10^{-4} cm / sec.

Layers of dry sand were poured in the reinforced rubber membrane up to a height of about 15 mms. Each layer was tamped by a light hammer to get the required density. After only a few tests it was possible to anticipate the tamping effort necessary to obtain the required density. Accordingly, samples were prepared with relative densities varying from 54.28% to 85.71%. The cross-sectional area of the samples was 50 cm². Ribbed top and bottom caps were used to achieve uniform deformation of the sample in simple shear [4]. The sample was then mounted in the loading device and consolidated under a vertical pressure σ'_{vc} = 2.5 kg/cm². Thereafter, the required horizontal cyclic shear stress was applied to the sample and the test was ready to start. A computer programme was used in evaluating the test results and correc-

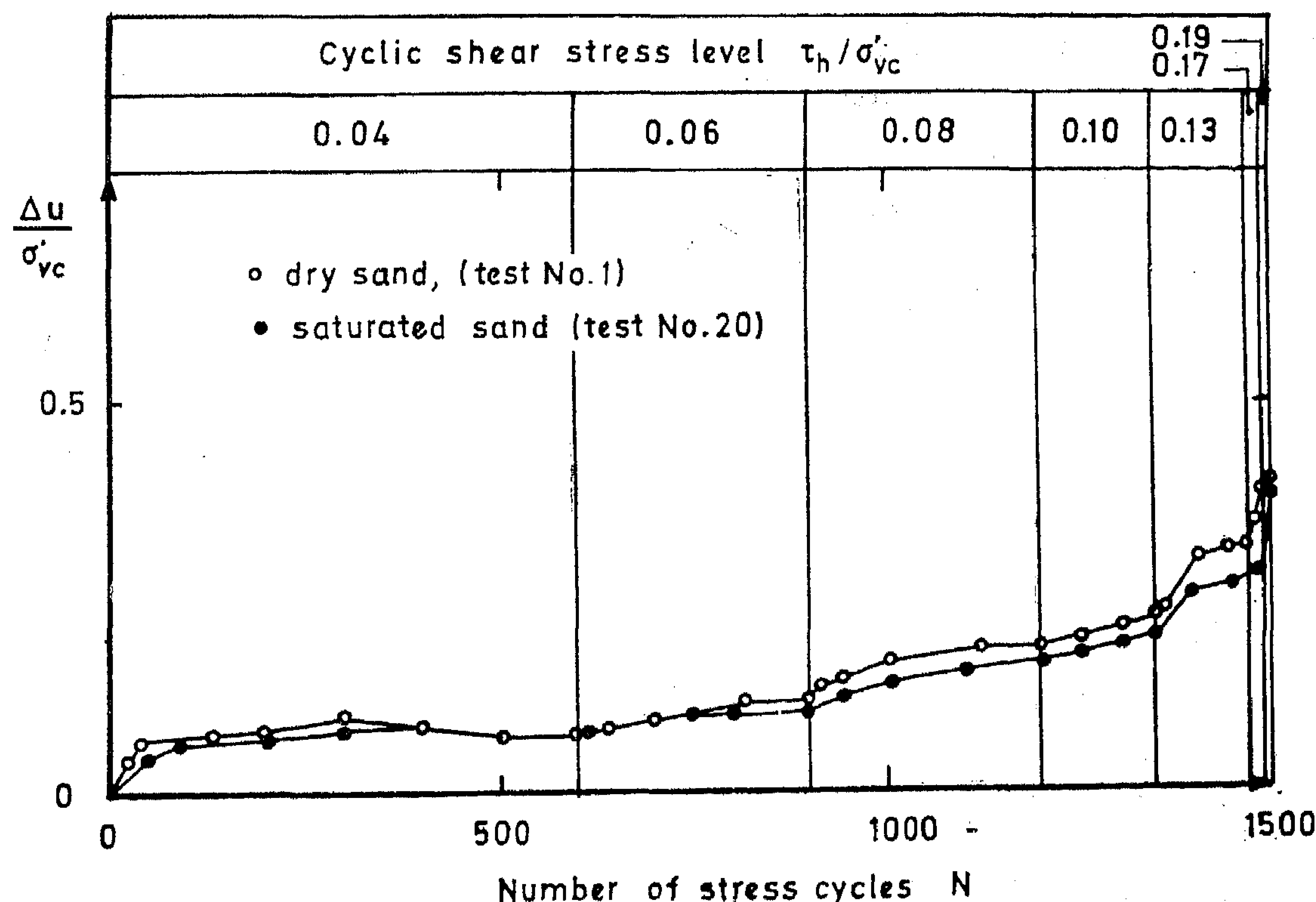


Fig. 3 Comparison between the constant-volume cyclic simple shear test results on dry and saturated samples of sand.

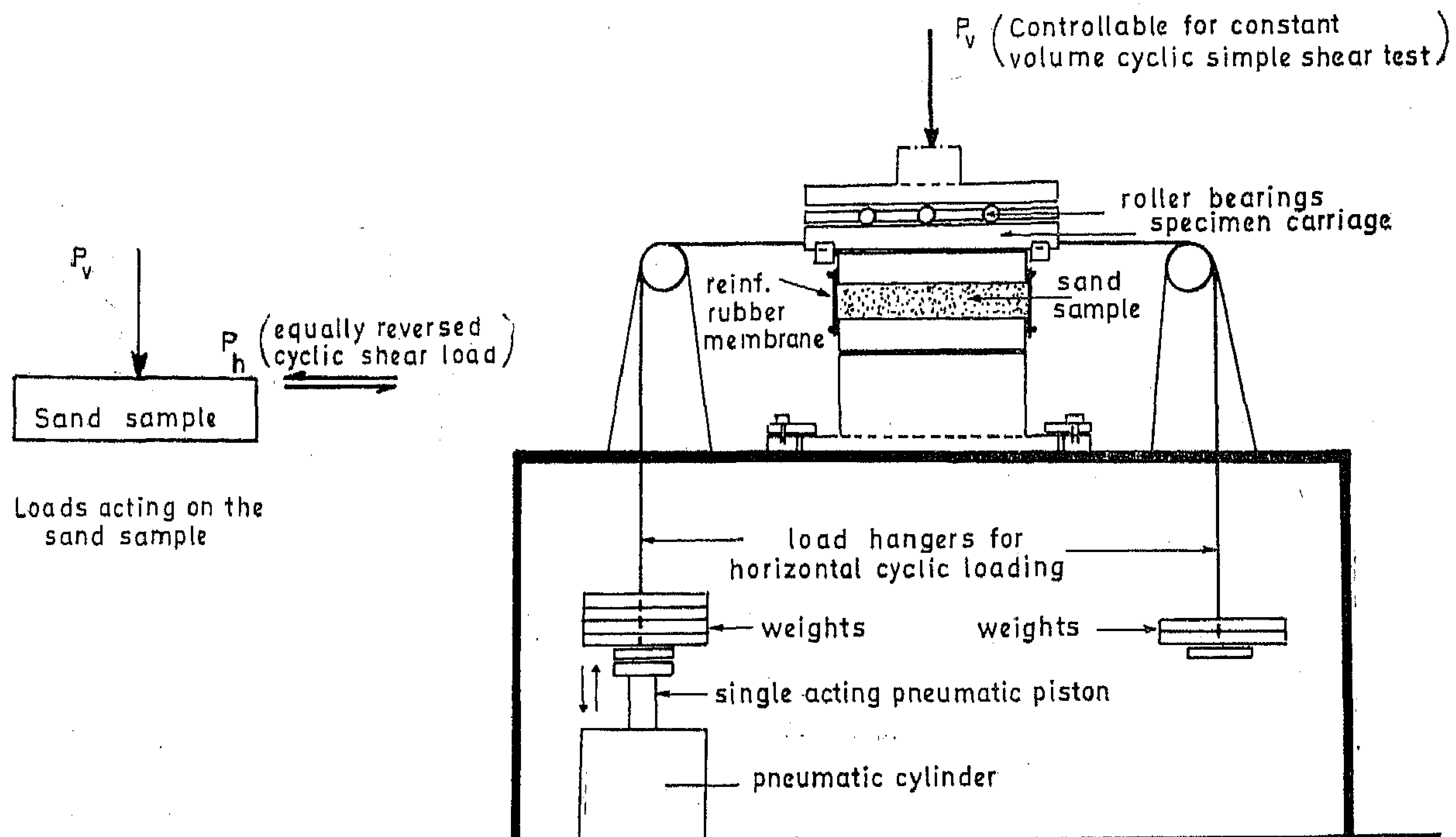


Fig. 1 Schematic diagram showing the principles of cyclic loading.

shear stresses are applied by means of two load hangers placed on both sides of the sample and are connected to the specimen carriage by means of two wires. On one side the loads hang freely, and on the other side they are simply supported by a single acting pneumatic piston so that the loads act on the sample only when the piston is in its lower position. The speed of the pneumatic piston can be varied by two adjustable valves placed at the ends of the pneumatic cylinder. Thus, the frequency of the cyclic loading can be adjusted. The pressure in the system is kept constant by means of a pressure regulator. The cycli loading wave form shown in Fig. 2 was used for all the tests described herein.

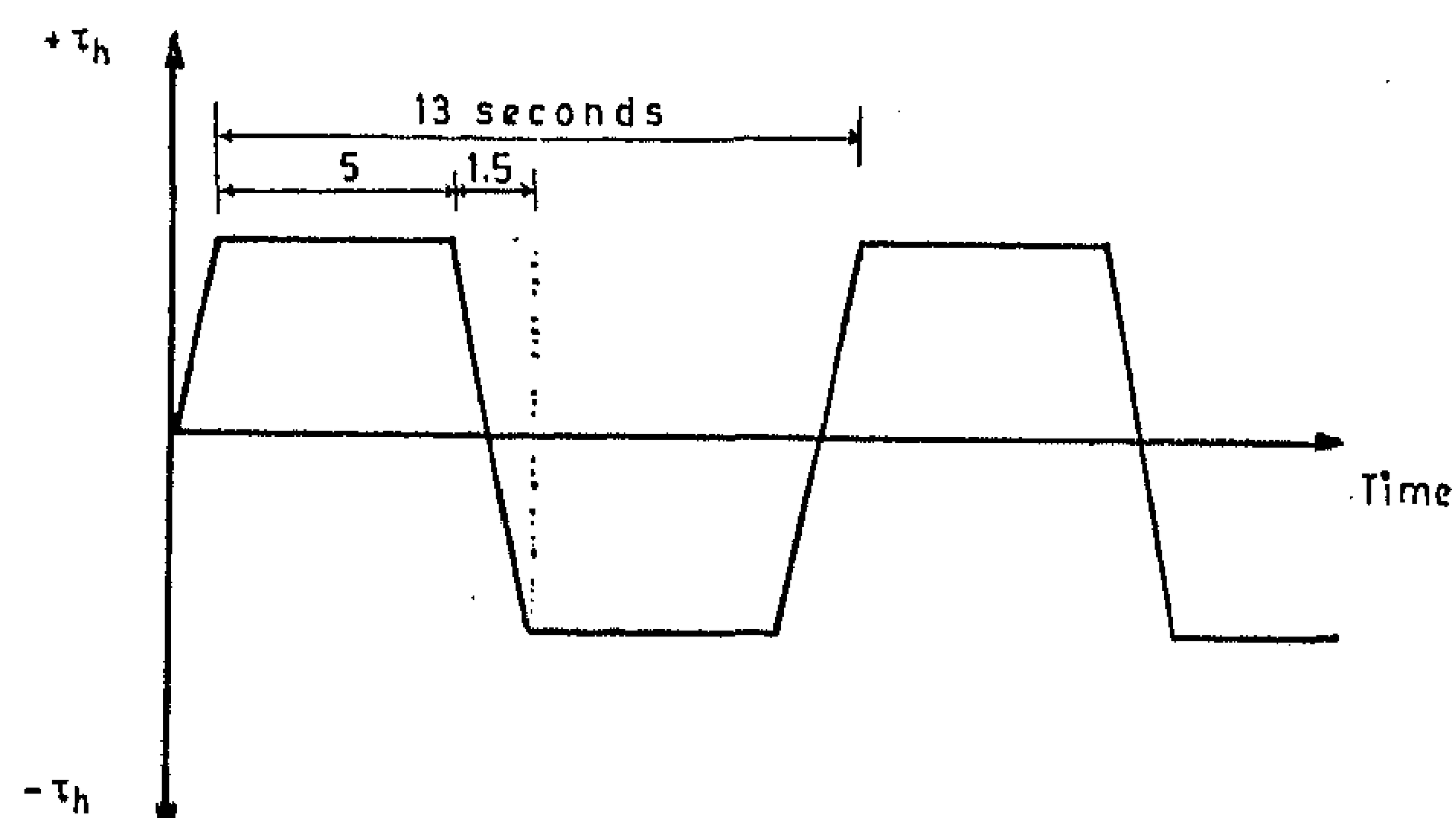


Fig. 2 Wave form of cyclic loading.

In problems dealing with earthquakes, it is well known that very little drainage can occur in large soil masses to relieve the ekcess pore water pressure induced by short wave length cyclic loading. However, the susceptibility to drainage may be somewhat increased in the case of sea waves. This is due to the long duration of sea waves as compared to earthquake waves. The tests described in this paper were conducted on samples of sand under no volume change conditions; i.e. under "undrained" conditions. Therefore, the results obtained will give a lower factor of safety against the applied loads than that which can be expected in the field where some drainage will probably take place.

In a constant-volume test the volume of the sample is kept unchanged by regulating the vertical pressure to maintain a constant sample height throghout the test. The change in vertical pressure corresponds to the change in pore water pressure in the sample if the test had been run as an ordinary undrained test with pore-water pressure measurement [1].

SHEARING RESISTANCE OF SAND UNDER THE EFFECT OF SEA STORMS

by

ABDELMONEM A. MOUSSA*

INTRODUCTION

The behaviour of sand under cyclic loading has received increased attention during the past twenty years. Numerous studies have been made to determine the strength of cohesionless soils under cyclic loading using different types of shear apparatus and different test procedures. The following summarizes the most significant observations obtained from the literature.

1 — The soil can deform and fail in such a way that pore-water pressure induced by cyclic loading is not dissipated over the short duration of load application. Florin and Ivanov [3] observed that even coarse sand deposits remain essentially undrained for several minutes after being loaded.

2 — Up to a certain number of load cycles the strains are very small, but the cyclic pore water pressures show accumulative increases. Shear strains subsequent to liquefaction can be extremely large [4].

3 — Liquefaction of cohesionless soils depends on: density, magnitude of cyclic shear stress, number of load cycles, initial effective stresses, previous stress history, mode of failure, and type of testing equipment.

4 — Cyclic simple shear loading simulates to a greal extent the field cyclic loading conditions [5].

Gravity structures in the sea are usually subjected to minor waves followed by relatively quiet periods before the occurrence of the maximum design loading conditions. Knowledge of the time history of all the waves constituting the entire storm is necessary in studying the stability of such structures.

The present paper investigates experimentally the excess "pore pressure" induced in medium dense and dense sands due to increased increments of equally reversed horizontal cyclic simple shear stresses. These reversed stresses simulate the loads on the soil from a gravity structure which is subjected to a sea storm.

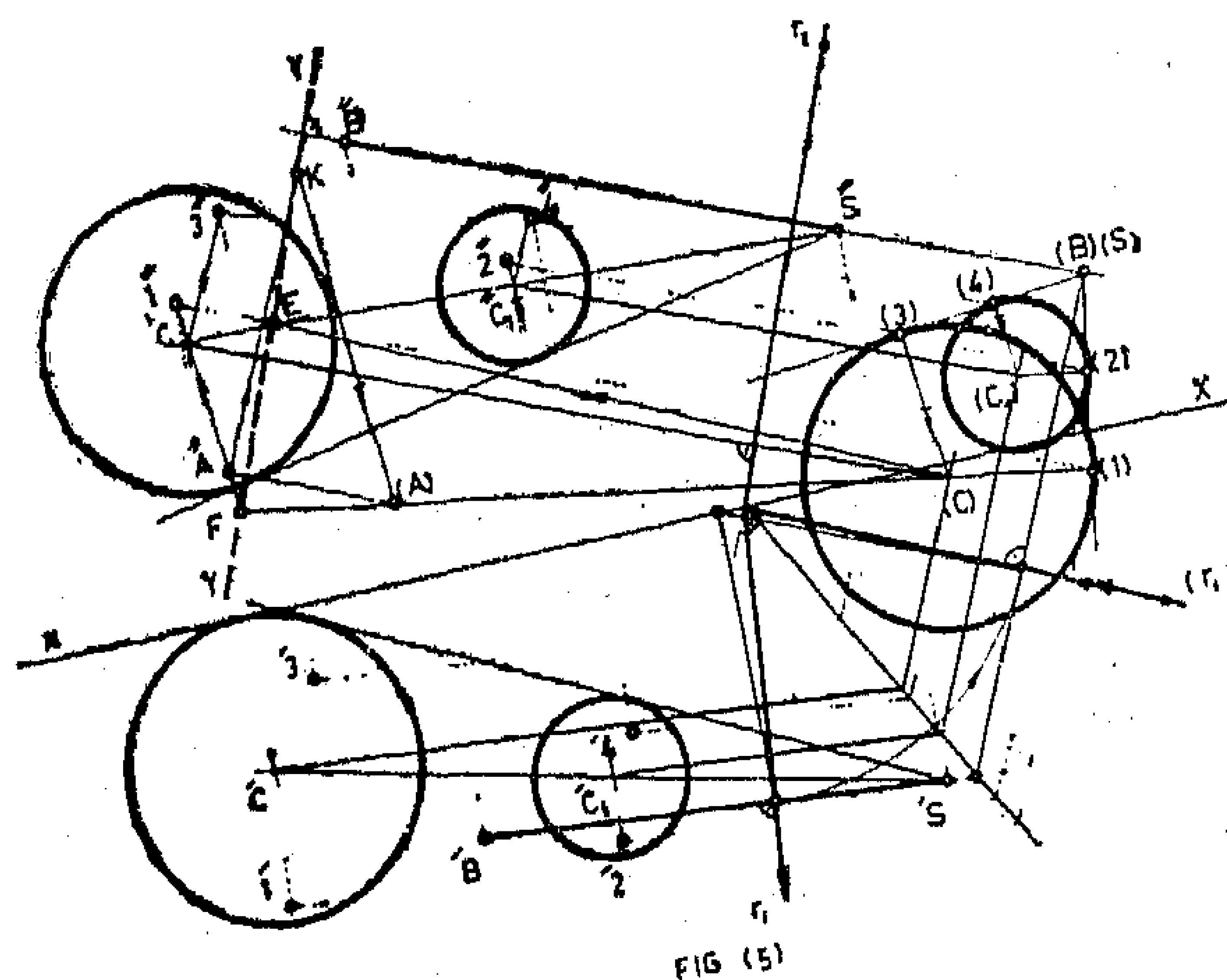
This study is part of a research project on cyclic loading on sand carried out at the Norwegian Geotechnical Institute, as related to the offshore work in the North Sea.

TEST PROCEDURE AND DESCRIPTION OF SAND

The tests were carried out in the direct simple shear apparatus designed at the Norwegian Geotechnical Institute. A general description of the apparatus is given by Bjerrum and Landva [1]. so that only a few features need be mentioned here. The apparatus is provided with a vertical loading system which can be controlled to keep the height of the sample unchanged in constant-volume test. The sample is mounted in a reinforced rubber membrane which restrains the lateral deformations but allows the sample to strain in simple shear and plane strain. In November 1972 the apparatus was equipped with a device for cyclic loading. Using this device, it is possible to apply horizontal cyclic shear stresses with adjustable amplitudes and frequencies. As can be seen from Fig. 1, the horizontal cyclic

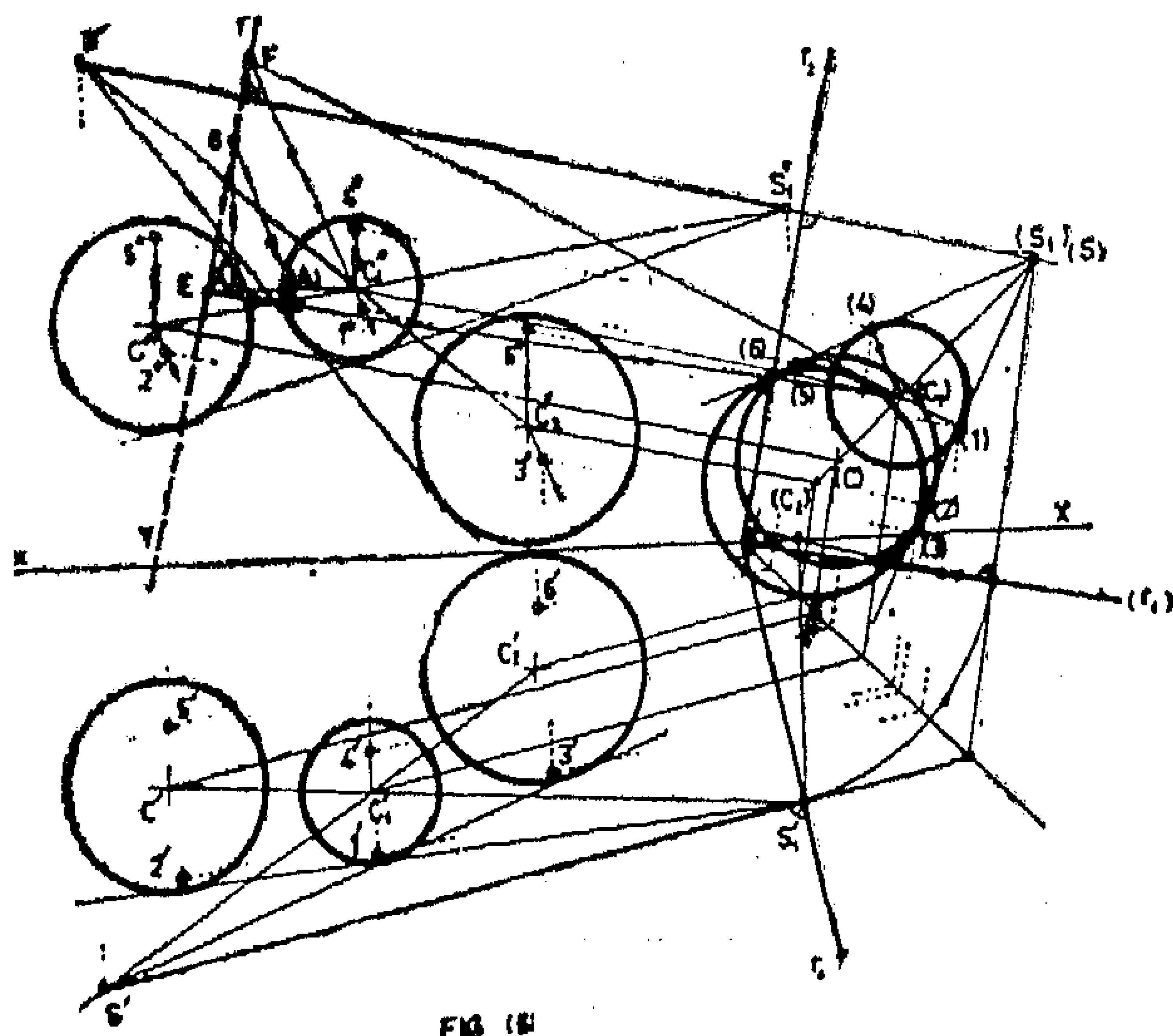
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their ends and we can easily find their horizontal projections.


FIG (5)

The third problem : Given three spheres with centres C, C_I and C_2 Fig. (6). It is required to construct the tangent planes to the given spheres.

Solution : The planes tangent to the three spheres will be tangent to the cones enveloping two spheres, therefore they pass through the line which joins the vertices of the two cones. There will be eight solutions to the problem, two of which, are given in Fig. (6).


FIG (6)

We envelope the two spheres with centres C & C_I by a cone, the two projections of its vertex are S_I & S_I, then we envelope the two spheres with centres C_I & C_2 by another cone, the two projections of its vertex are S' & S''. We join the two vertices of the cones S & S_I to get the line through which all the tangent planes pass.

We construct the perpendicular auxiliary projections of the three spheres and the lines S S_I on an auxiliary plane perpendicular to the direction S S_I The spheres will be projected in great circles and the line S S_I in a point, then we rotate the auxiliary plane about its frontal trace, we can get three great circles with centres (C), (C_I) and (C_2) & the point (S) (S_I).

Through the point (S)(S_I) we draw a line touching the three great circles in the points (1), (2) & (3), they are the auxiliary projections of the points of contact. We proceed as before.

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the centre C a horizontal line perpendicular to AB (with its frontal projection C"E and its projection in rotation is parallel to (r_I) passing through (C)). The two projections of the horizontal line intersect in point E, which lies on the axis of affinity. Through point E we draw the axis of affinity for all perpendicular planes to AB, which will be perpendicular to A"B". To get the projections of the points of contact, we join (C) & (1) to meet the axis SS in point F, then join F & C" and by the direction of affinity (parallel to A"B") we can find 1" from which we get 1'. By the same way we can get the projections of point (2). The points 1 & 2 with the line AB give the two tangent planes.

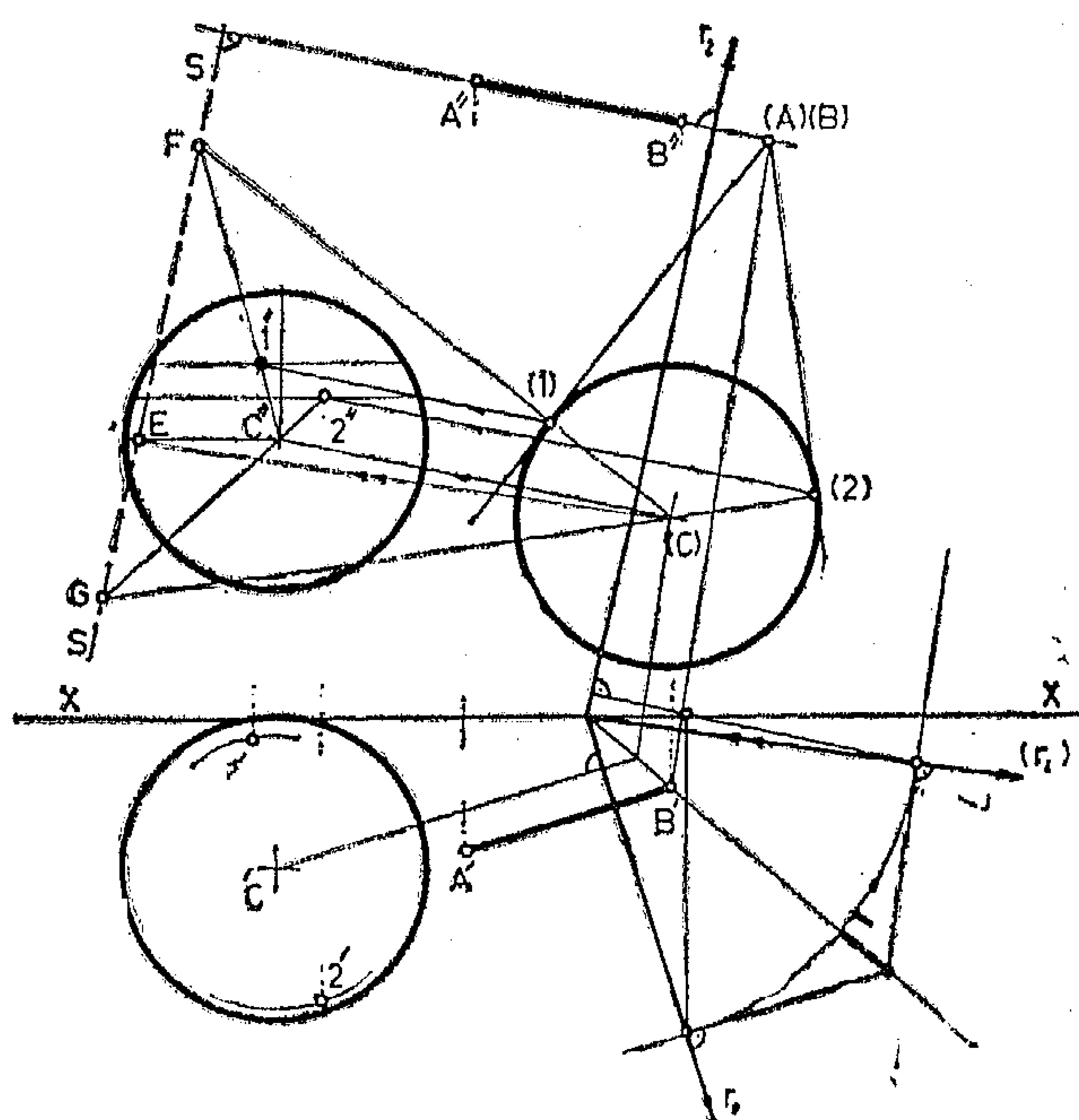


FIG. (4)

The second problem : given two spheres the centres C & C_I Fig. (5) and point B. It is required to construct the planes tangent to the two spheres passing through the given points B.

Solution : through B we can construct two tangent planes touching each of the two cones enveloping the two spheres.

We can construct the two planes tangent to the two spheres and pass through the line which joins point B and the vertex of the cone S. The vertex S can be constructed by drawing two tangents to the horizontal projections of the two spheres which meet the line of centres in point S.

We construct the perpendicular auxiliary projections of the two spheres and the line BS on an auxiliary plane perpendicular to the direction BS, each sphere will be projected in a great circle and the line BS in a point. We rotate the auxiliary plane about its frontal trace to coincide with the frontal plane, we get the great circle for each sphere, their centres are (C) & (C_I) and the projection of BS is the point (B) (S).

The two tangent planes to the two great circles which are perpendicular to the auxiliary plane pass through the point (B) (S). We can find the tangent points (1) & (2) by drawing a perpendicular to the tangent plane from (C) & (C_I), by the same way we can get (3) & (4), the tangent points of the second tangent plane.

By using the affinity between the auxiliary plane and the frontal plane, we can construct the frontal projections of the points of contact 1", 2", 3" & 4", so by drawing a horizontal line through the centre C, we find the axis of affinity YY as before in the first problem.

To construct the frontal projection 1" of the point (1) we join (1) & (C) to meet the axis YY in point F, then join F & C" and by the direction of affinity which is parallel to S" B" we get 1" which leads to 1'. By the same way we find the two projections of point 2.

To get the frontal projections of the points 3 & 4, take any point as (A) from the ray (C) F and draw a line through this point Parallel to (C) (3), which interseds the axis YY in point K, the line K A" is the direction of the frontal projectons of the radii, we get 3" & 4" at

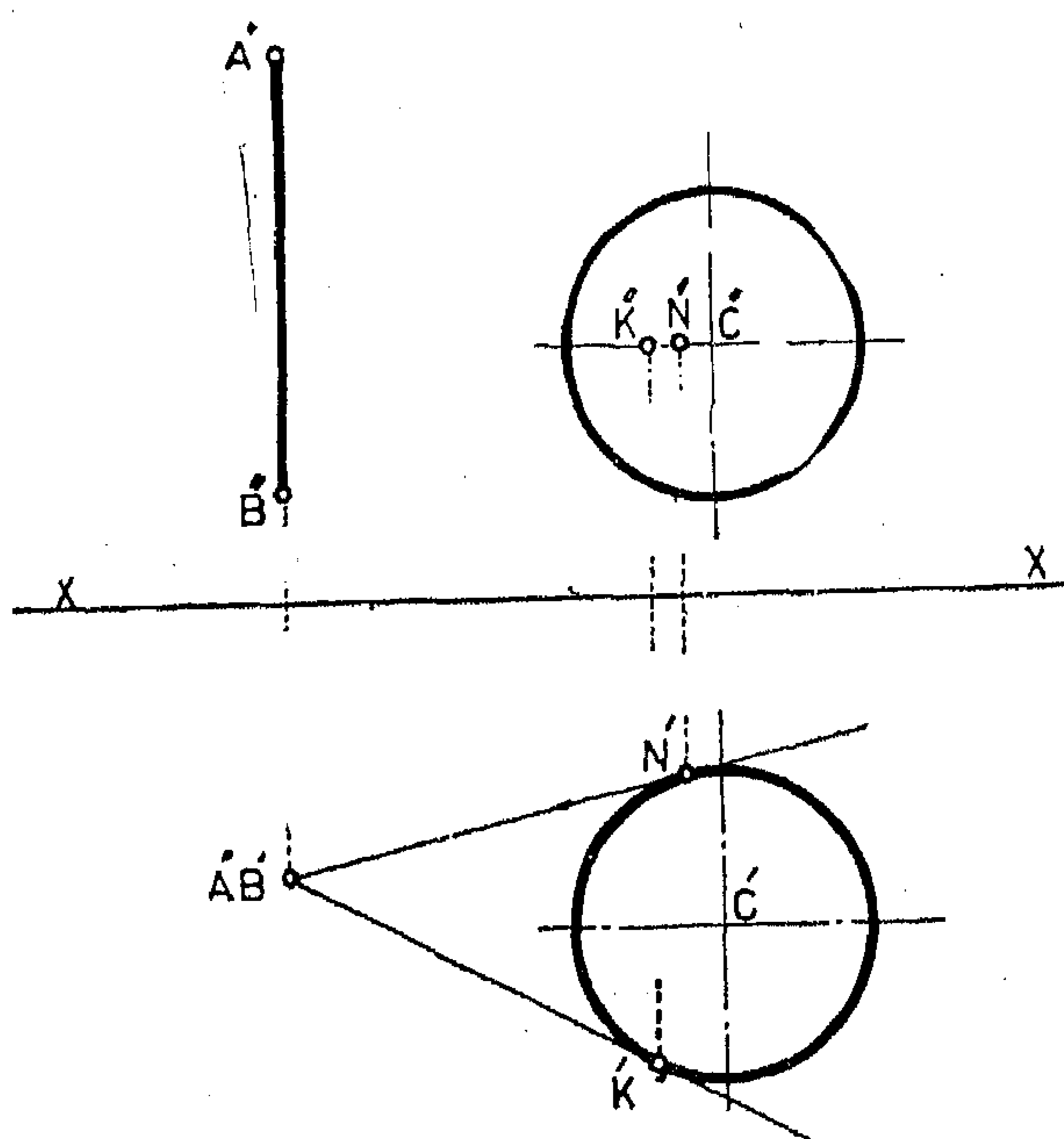


FIG. (2)

If the line AB is perpendicular to one of the projection planes, for example perpendicular to the horizontal plane Fig. (2), in this case the planes tangent to the sphere and pass through AB are easily constructed. We draw from A'B' two tangents A'N' & A'K' to the horizontal great circle, we get the tangent points N & K each of them with AB gives a plane tangent to the sphere.

If the line Abis a general line Fig. (3), we need two auxiliary planes, the first is parallel to the line AB and the second is perpendicular to the last position. We find the two tangent points K'_5 & N''_5 and then return them to their original projections.

In this paper we try to give new methods for solving the following problems by using the general auxiliary planes.

(1) The planes tangent to a sphere passing through a given line.

(2) The planes tangent to two spheres passing through a given point.

(3) The planes tangent to three spheres.

The first problem : given the line AB and a sphere with a centre C Fig. (4). It is required to construct the planes tangent to sphere passing through AB.

Solution : we construct the perpendicular auxiliary projections of the sphere and the line AB, the sphere will be projected in a great circle and the line in a point, then rotate the auxiliary plane about its frontal trace, we get the great circle with centre (C) and the point (A) (B).

To construct (C) and (A) (B) we draw an auxiliary plane perpendicular to the line AB, then we rotate this plane about its frontal trace to coincide with the frontal plane, we get (r_I) and we project the sphere and the line AB (we can take the points from r_I to (r_I) through the bisector instead of using the compasses) and rotate them to get (C) and (A) (B). We draw from the point (A) (B) two tangents to the great circle with centre (C), we get the tangent points to the surface of the sphere in rotation.

To construct the frontal projections of the points of contact we use the affinity between the perpendicular auxiliary plane to AB and the frontal plane passing through the centre of the sphere. To find the axis of affinity SS, we draw through

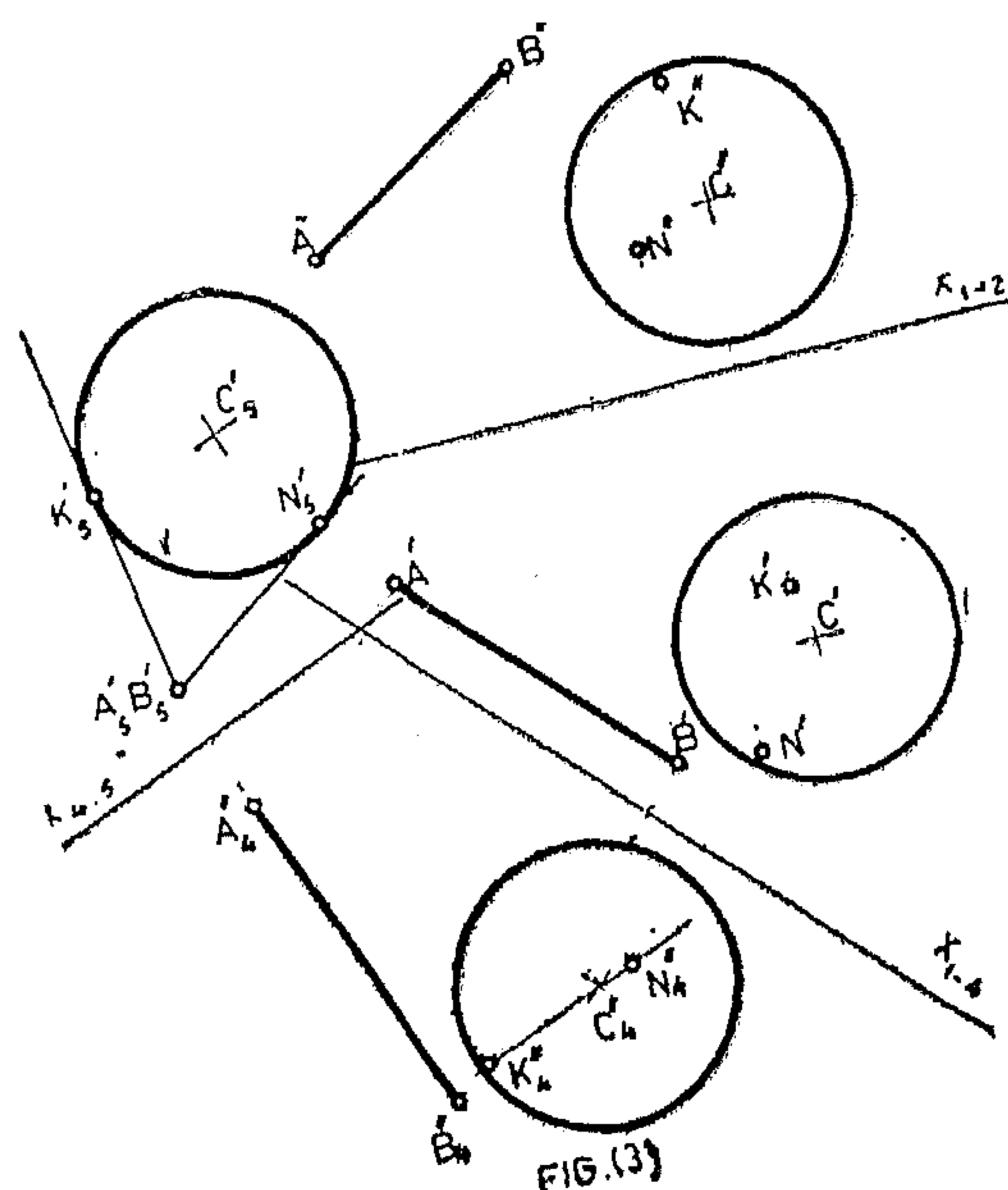


FIG. (3)

REPRESENTATTON OF PLANES TANTGENT TO SPHERS BY USING GENERAL AUXILIARY PLANES

By

DR. MOHAMED ABD EL-HAMID EL-RAKABAWY

The graphical method for representing planes tangent to sphere was given by Monge more than 150 years ago. He gave two different methods to construct the planes tangent to a sphere passing through a given line.

Monge did not give the solution to the problems of constructing planes tangent to two or three spheres, because of the difficulty of their construction.

Now in Descriptive Geometry there are new methods used to change the projection planes, one of them is using general auxiliary planes. This method does not only give easy and quick solutions but also simplifies the complicated construction.

We shall see one of the Monge's methods for representing the planes tangent to a sphere and passing through a given line.

Let that given line be AB and sphere with a centre C. Fig. (1).

Solution : Through the centre C we construct a plane perpendicular to AB. This plane is represented by two lines; horizontal line CG and frontal line CF, and P is the intersection of AB with the plane.

The planes tangent to the sphere passing through AB touch the sphere in points on the great circle which is perpendicular to AB. The lines of intersection (PN and PK) of the plane perpendicular to AB with the plane tangent to the sphere passing through point P, will touch the great circle and will be at a right angle with AB. PN and AB & PK and AB give the two tangent planes.

It means that the problem could be summarised in constructing a line passing through point P and touch the great circle perpendicular to AB.

Therefore we rotate the great circle with the point P about the horizontal line CG to the horizontal position, we get (P) and the great circle coincides with its horizontal projection.

We draw from (P) two tangents (P) (N) & (P) (K) to the horizontal great circle, and get the tangent points N & K, then return these points to the horizontal and frontal projections, each of them with the line AB gives a plane tangent to the sphere.

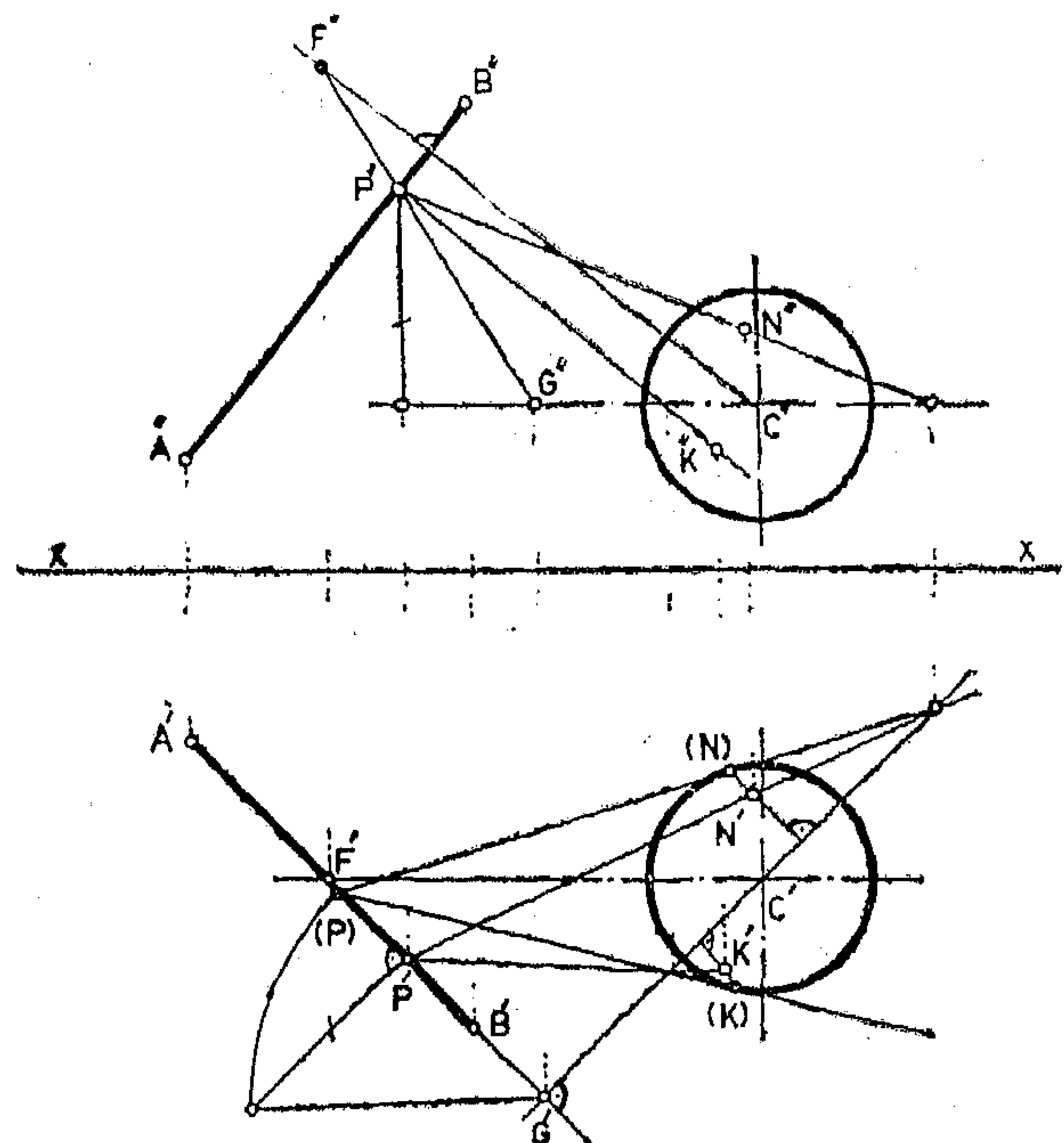


FIG (1)

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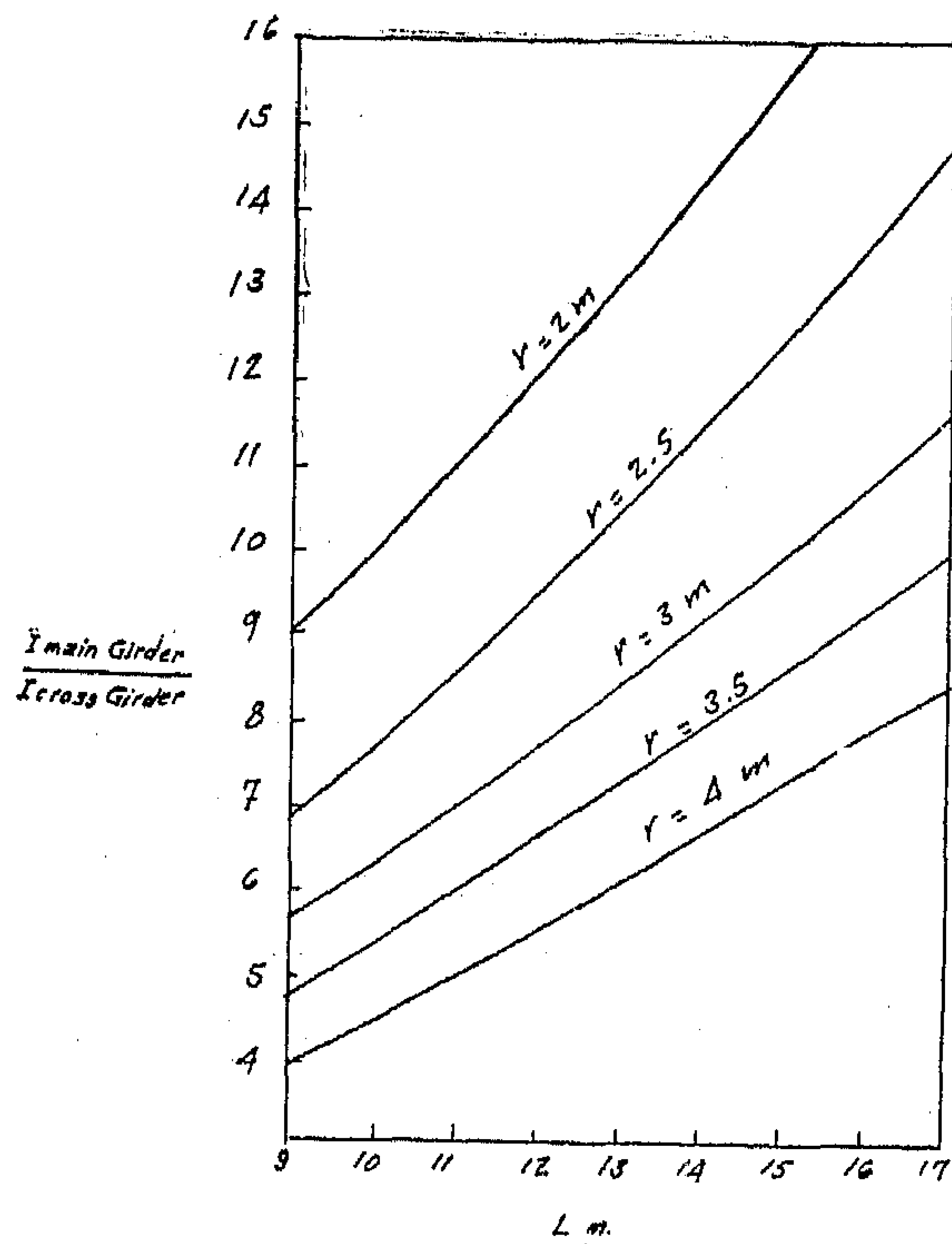


Fig.(7) Relative stiffness for Type (4) of P.F

An equal distribution of the dead load among the points of support can be acheived by a suitable choice of cross sections of the polygonal frame. It is not necessary to have an infinetly rigid polygonal frame on the central pier, if only the relative stiffness of the different members satisfy the conditions of equal reactions.

Thus it is recommended to use the given curves for the different types of polygonal frames to find out the required stiffness ratios which fulfil the conditions of equal reactions.

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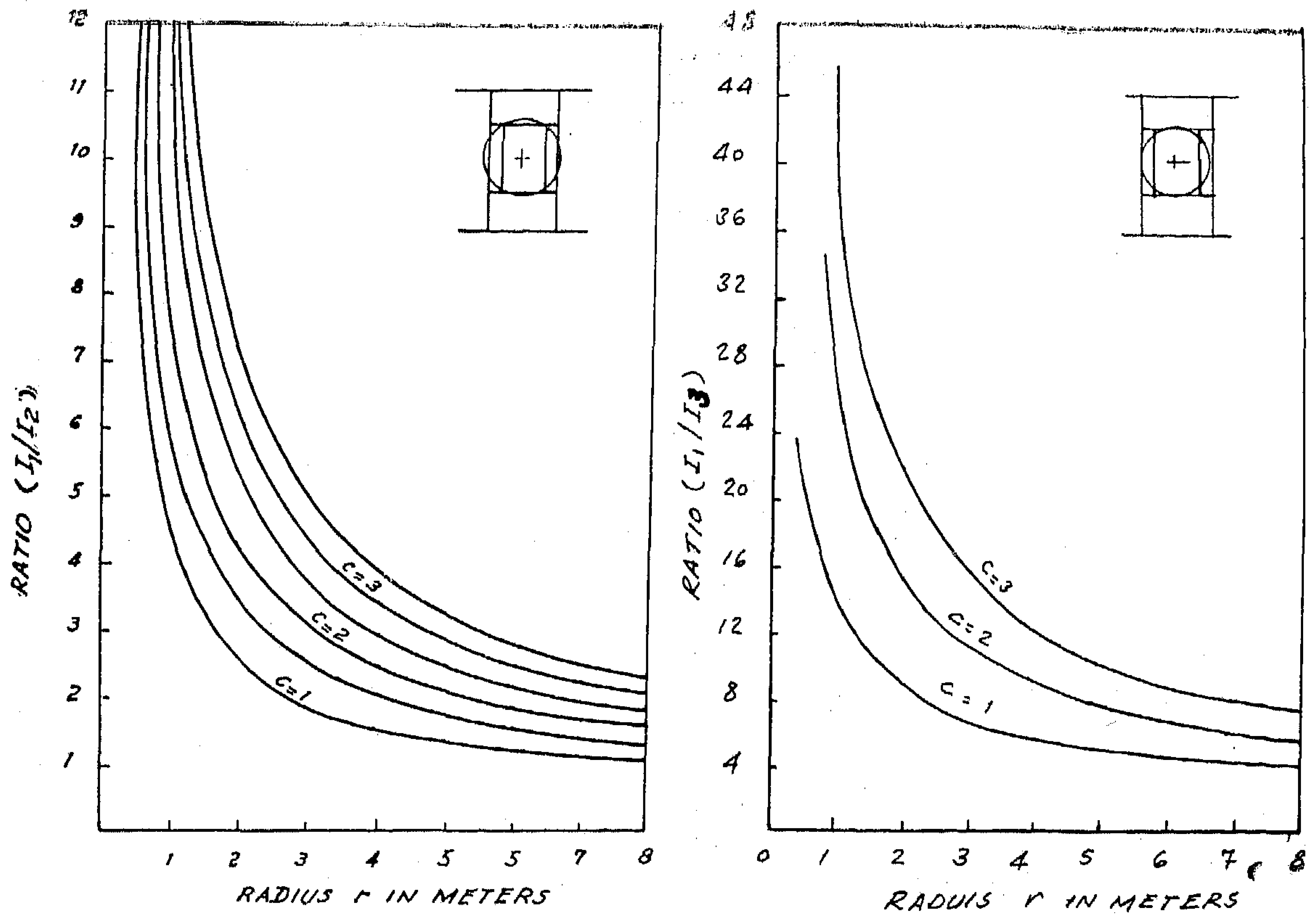


Fig. (5) Relative stiffness for TYPE (2) of Polygonal frame

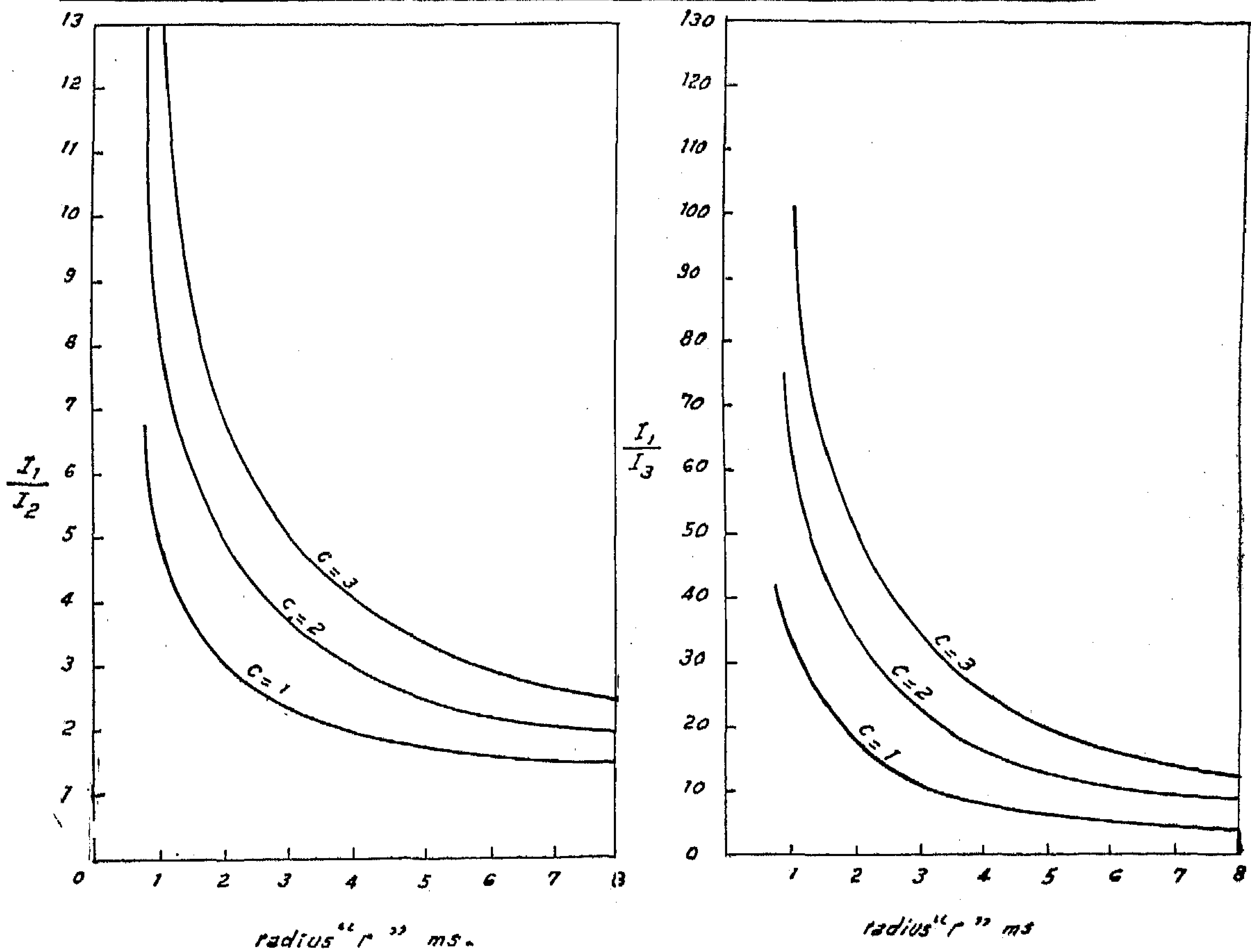


Fig. (6) Relative stiffness for Type (3) of P.F.

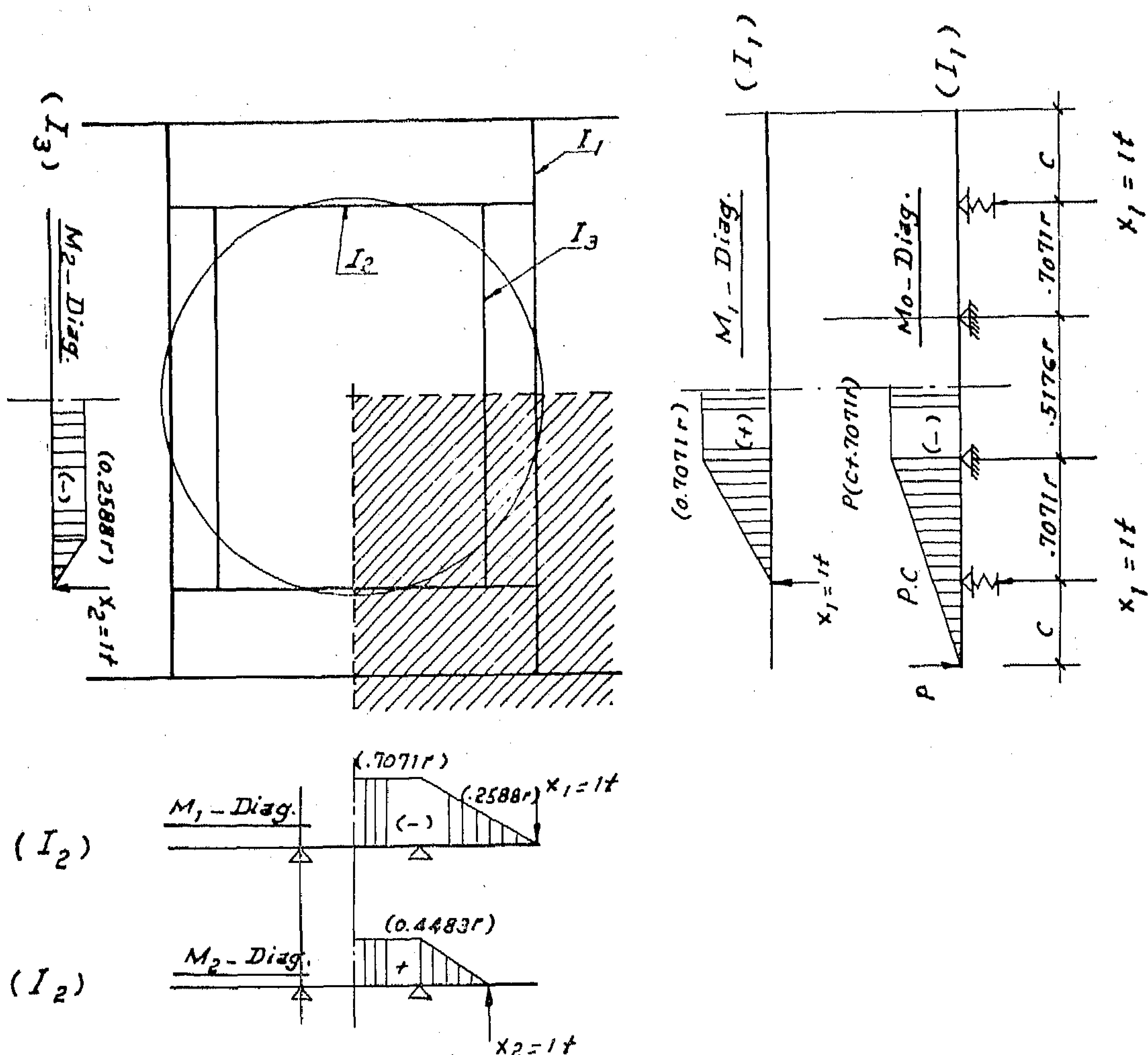


Figure (4): Type (2) of Polygonal frame.

3. CONCLUSIONS AND RECOMMENDATIONS :

In previous designs of polygonal frames of swing bridges the moments of inertias of the main-stringers and main-cross girders were assumed to be infinite. This means that these beams are absolutely rigid and consequently all reactions due to dead loads are equal. In this way, it is possible to determine the straining actions of the different members directly without going through the trouble of solving elastic equations. This rough procedure is often carried out in routine design However if the actual moments of inertia were considered, the reactions on the central pier would not be equal.

Equation (4) is plotted for practical use in figure (3).

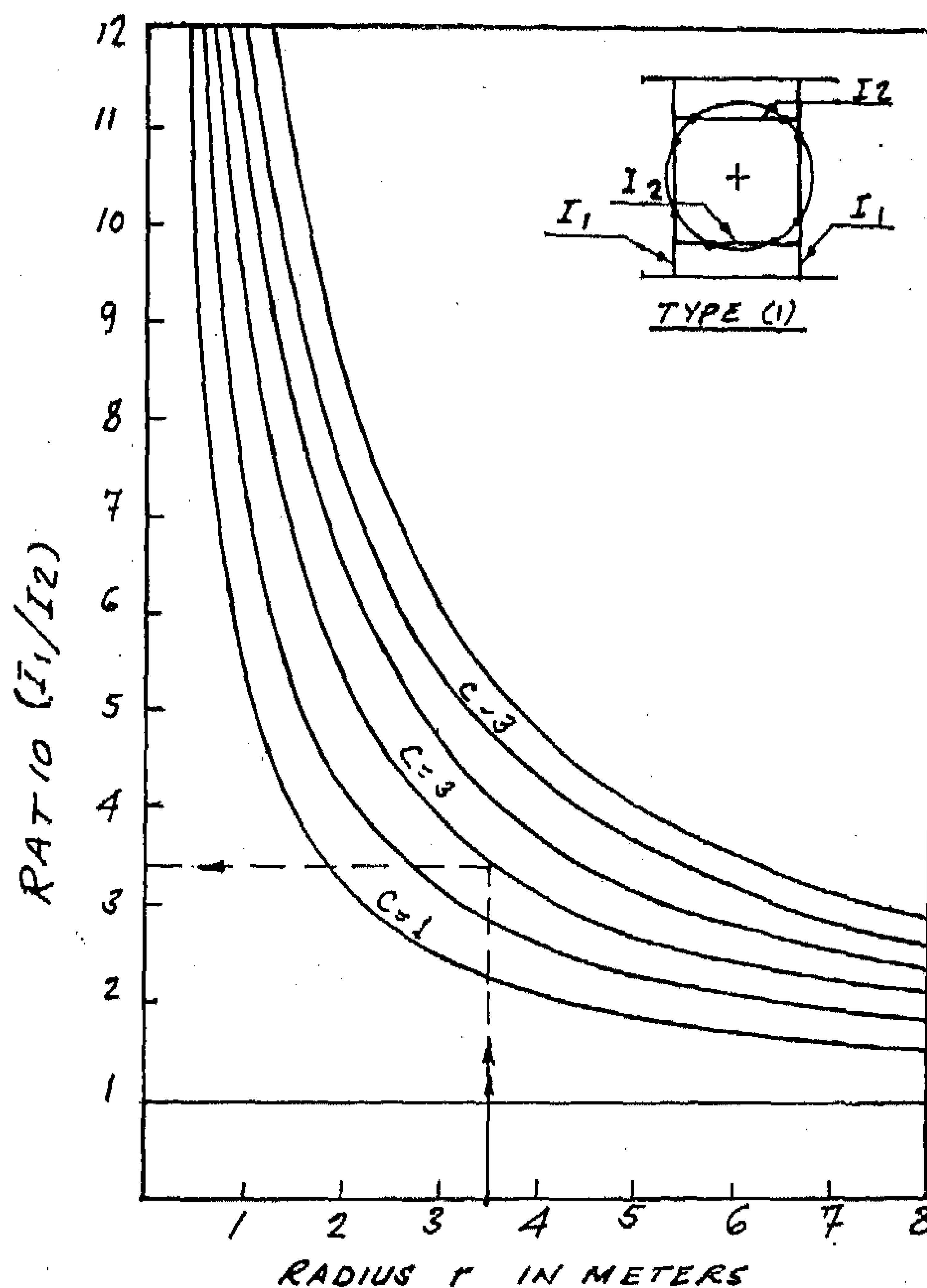


Fig. (3) Relative inertias of main cross-girder to main stringer for

Once the distance "C" and the radius "r" are known, the ratio (I_1/I_2) can be read off the vertical coordinate of figure (3). If this ratio is respected in the design of the swing bridge of type (1), this would ensure that the reactions on the conical rollers are equal when the bridge is opened. Thus no excessive stresses would occur on any of those rellers.

For type (2) of polygonal frame:

Keeping in mind that the M_1 & M_2 diagrams are composed of more than one beam at a time, a similr formula for the stiffness ratios (I_1/I_2) and (I_1/I_3) can be obtained as follows:

$$E\delta_{10} = -\frac{1}{I_1}[Pcr^2(0.43298) + Pr^3(0.24721)] \quad (5\text{-}a)$$

$$E\delta_{11} = -\frac{1}{I_1}[r^3(0.24723)] + \frac{1}{I_2}[r^3(0.24723)] \quad (5\text{-}b)$$

$$E\delta_{12} = -\frac{1}{I_2}[r^3(0.13806)] \text{-----} \quad (5\text{-}C)$$

$$E\delta_{22} = \frac{1}{I_2}[0.08204\, r^3] + \frac{1}{I_2}[.05312\, r^3] \quad (5\text{-}d)$$

The total reaction of the bridge = 4P.
Reaction per roller = 4 P/12 = P/3

$$X_1 - X_2 = \frac{P}{3}$$
$$X_2 = \frac{P}{3}$$
$$\therefore X_1 = \frac{2}{3}P$$

$\therefore \delta_{10} + x_1\delta_{11} + x_2\delta_{12} = 0$ Gives :

$\therefore (I_1/I_2) = 3.57244\ c/r + 0.67986$ (6)

and $\delta_{20} + x_1\delta_{12} + x_2\delta_{22} = 0$ Gives

$(I_1/I_3)\ 13.0305\ c/r + 2.57835$ (7)

If the preceeding procedure is followed for the other two types of polygonal frames, the relative stiffness ratios are as follows :

For Type (3);

$(I_1/I_2)\ 4.04\ c/r + 1$ (8)

$(I_1/I_3)\ 33.4464\ c/r + 0.570$ (9)

For Type (4);

$$\left(\frac{I_2}{I_1}\right) = \frac{0.176\,L^2 + 0.082\,Lr - 0.038\,r^2}{0.082(Lr + r^2)} \quad (10)$$

where L is the length of main girder between the end support and the main-cross girder.

Figures (5,6 and 7) show the relations for every type of polygonal frames.

The Relative Stiffness of the Different Beams of Polygonal frames:

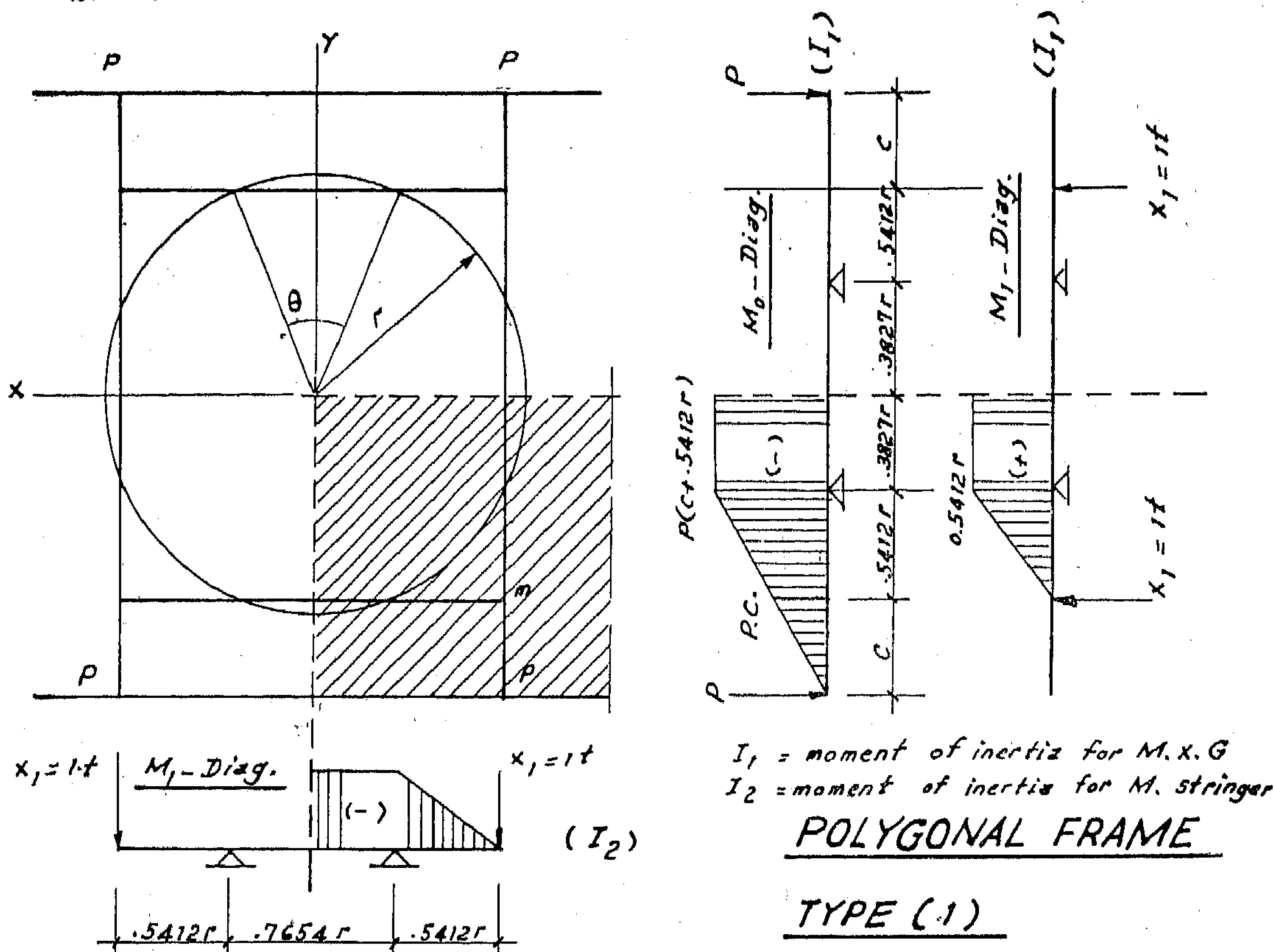


Fig.(2): Type (1) of Polygonal frame.

y-y axes, then it is possible to consider one quarter only of the polygonal frame.

Using the method of virtual work, the redundant is selected to be the reaction between the main-stringer and the main-cross girders. Keeping in mind that the M_I -diagram is composed of two diagrams, one for the main stringer and the other for the main-cross girder; the deflection at point m is determined from :

$$\delta_{I0} = \int_0^l \frac{M_0 M_I}{E I_1} dl \qquad (1)$$

Where I_1 is the moment of inertia of the main-cross girder. Assuming the total reactions of the open bridge on the main cross-girder to be 4P. Then for equal reactions over supports, the redundant force X_I = 4 P/8 = P/2

And the relative moments of inertia (I_1 / I_2) is obtained from the condition :

$$\delta_{10} + X_1 \delta_{11} = 0, \; X_1 = P/2 \text{ ......} (2)$$

Carrying out the integrations δ_{I0} and δ_{II}, the following expressions are obtained:

$$E\delta_{10} = -\frac{1}{I_1}[0.35353\, Pc\, r^2 + 0.1663\, Pr^3] \qquad (3\text{-a})$$

$$E\delta_{11} = -\frac{1}{I_1}[0.16489\, r^3] + \frac{1}{I_2}[0.16489\, r^3] \qquad (3\text{-b})$$

Substituting equations (3-a,b) into equation (2), the following relation is obtained:

$$I_1 / I_2 = 4.2884\, c / r + 1 \qquad (4)$$

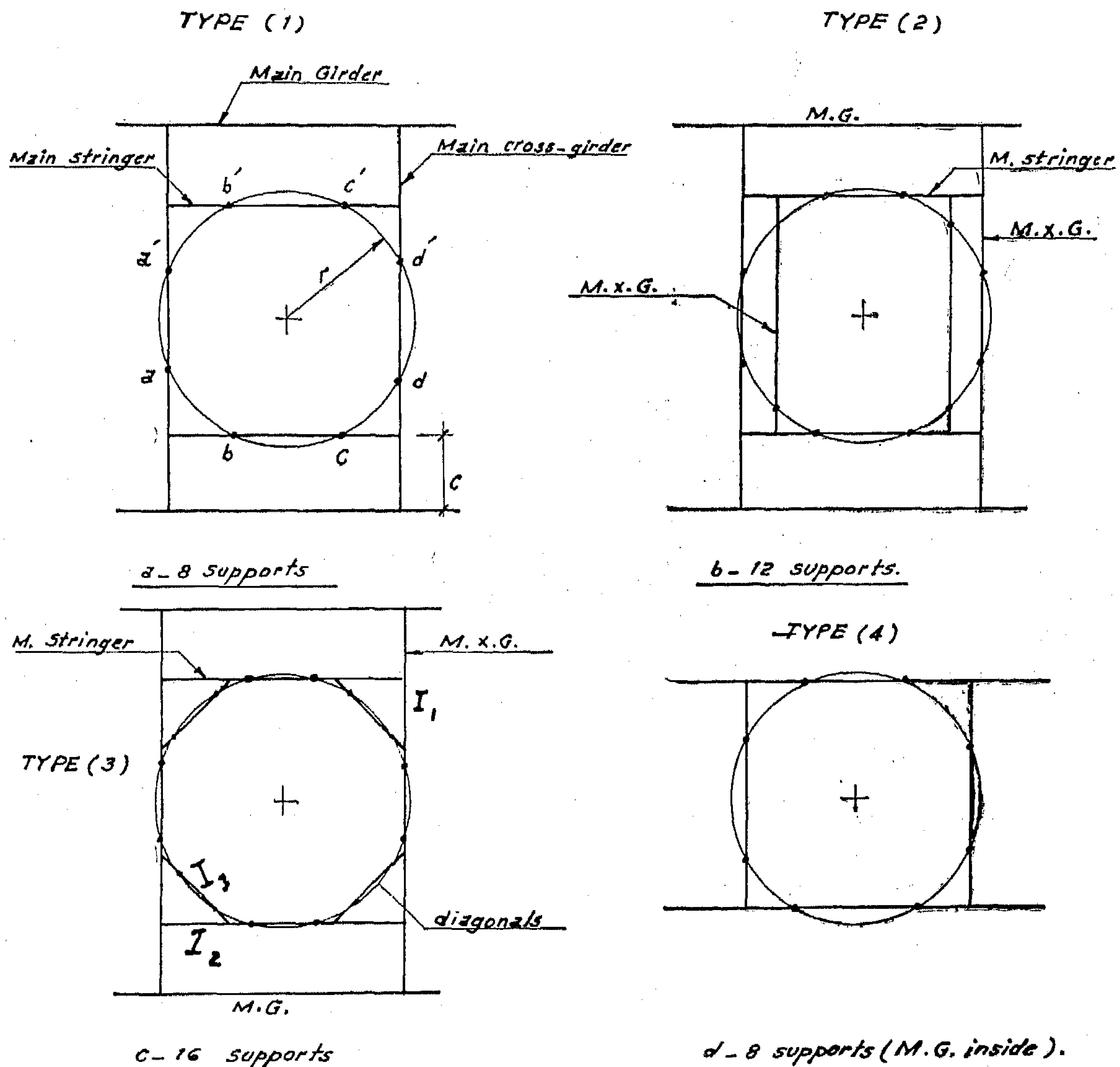


Figure (1) : General Arrangements of different types of Polygonal frames (Girder Grating).

For TYPE (3); length of main-stringer = 1.9616 r

length of main-cross girder = 1.9616 r + 2 C

length of diagonal beam = 0.8124 r

For TYPE (4); length of main-cross girder = 1.8478 r

2. THE RELATIVE STIFFNESS OF THE DIFFERENT BEAMS OF POLYGONAL FRAMES

For Type (1) of polygonal frame :

In the open position, the main girders are loaded by Dead loads only, thus the loading is symmetrical about the x-x and y-y axes, Since there is symmetry of loading as well as geometry about x-x and

STUDY OF LOAD DISTRIBUTION ON FLOOR BEAMS OF SWING BRIDGES AT THE CENTRAL PIER

By

Dr. MOHAMED NABIL EL-ATROUZY.*

ABSTRACT:

Swing bridges are commonly used in Egypt to fulfill the navigation requirements. One of the most important factors in the design of swing bridges is the load distribution over the conical rollers of the central pier. In the open position, it is always desirable to have equal reactions on these rollers. Thus, it is the author's conviction that a study on the load distribution in swing bridges would help in future designs.

This study depends on two main factors. First, is the geometrical configuration of the polygonal frame (Girder-Grating) supporting the main girders on the central piers. The second factor is the stiffness ratios of the different beams composing the polygonal frames.

This paper presents several curves (for different polygonal frames), to give the best stiffness ratios of those beams so that the reactions on rollers are equal on the central pier in the open position.

INTRODUCTION :

There are numerous types of polygonal frames supporting the main girders at the central pier depending on the shape and manner of arranging the beams. Referring to figure (1), four types of the floor beams are shown.

In any bridge, it is known that the main girders are supporting the cross-girders, and the cross-girders are supporting the stringers. Here, at the central, pier, in open position in a swing bridge, the succession of load distribution is reversed. The main girder is supported on the main cross-girder, and the main cross-girder is supported on the main-stringer.

In this paper the method of virtual work in three-dimensions is used to find the best stiffness ratios of these main beams so that the reactions are equal when the bridge is opened.

1. GEOMETRIC RELATIONS:

Referring to figure (1-a), if the eight points of support (a,a',b,b',c,c' and d,d') are at equal distances, the lengthes of the main cross-girder and main-stringer are known in terms of the radius "r" and the distance "C". Referring to figure (2) it is seen that:

$\Theta = 360 / 8 = 45°$

length of main-stringer $= 2\ r \cos \Theta /2$
$= 1.8478\ r$

length of main-cross girder $= 1.8478\ r + 2\ C$

In a similar manner, the lengthes of main-cross girder and main-stringers are obtained for the other three types of polygonal fames. They are found to be as follows :

For TYPE (2); length of main stringer $= 1.9318\ r$

length of main-cross girder $= 1.9318\ r + 2\ C$

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of a smooth interface. For the results obtained when the core surface is roughned by the projection of the sand peaks into the core, there was also the coefficient C. This coefficient is calculated on the base of equations 9 and 10 with the use of the slide rule and when plotted on fig. (4) showed the same tendency that the coefficient C for the smooth interface offered, but with a higher value at the corresponding Q_a/Q_w and q_w. The line of argument that led to the presence of the coefficient C for smooth pipes still holds good for rough pipes. The higher value for C is expected as the projections of the sand grains are now interfering with the gas flow, thus superimposing more turbulence and still higher energy losses.

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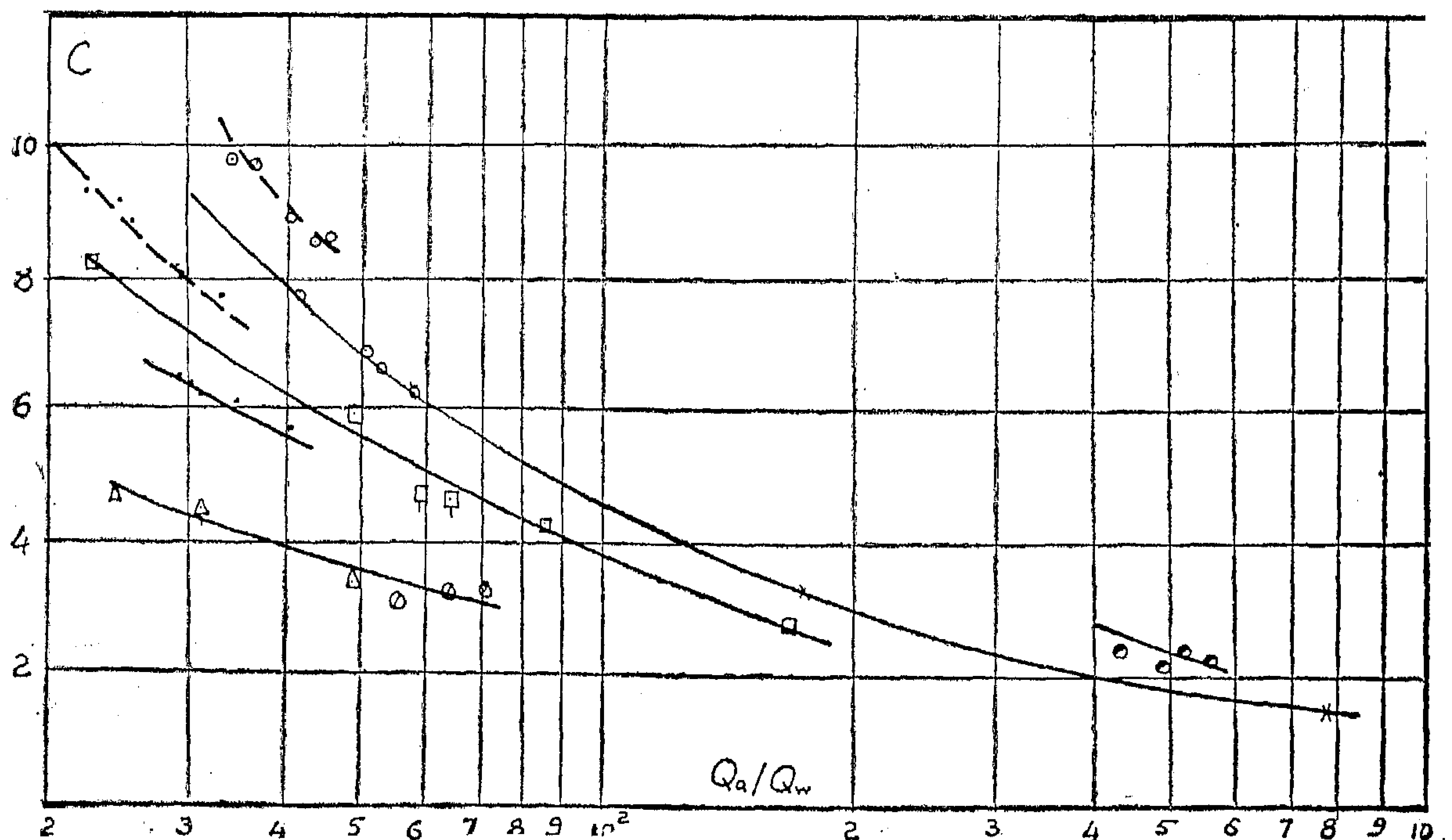
3) Kegel, P. "Two phase flow in vertical columns" S.B. thesis, Univ. of Delaware, 1948.

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vary both with the liquid parameter

$q_w = Q_w / 2\pi a \nu_w$

and the volumetric air water rate ratio as illustrated in fig. (4). During the tests the air discharge was ranging from about 3.5 lit / sec., which was the minimum to have annular flow (I)*, and a maximum of about 7 lit / sec. whilest the water discharge was restricted to two values of 116 and 162 lit / sec.; that gives a range for Q_a/Q_w from about 20 to 70 and a q_w of 1720 and 2400. It was found necessary to correlate the results with other investigators. The resuls for annular flow of air and water in smooth pipes carried out by Johnson and Abo-Sabe (2)*, by Kegel (3)* and by Taylor (4)* are shown in table (2). The value of the shear stress V* is calculated with the help of the suggested slide rule and the the correspon-ding coefficient C is thus plotted on the same fig. (4). The curves shows clearly the tendency the experiments offered, that there is a decrease of the coefficient C, with the increase of Q_a / Q_w for the same value of q_w or an increase in C for the same Q_a / Q_w if there is an increase in q_w. In other words the coefficient C decreases with the increase of either the gas discharge Q_a or the kinematic viscosity ν_w for a certain liquid discharge. This conclusion suggests that there exists a damping effect of the interfacial wave action with the increase of the gas discharge or liquid viscosity. At high gas rates, part of the liquid is likely to be picked up as entrainment and thus less will be left on the w all to cause the roughness and hence C will decrease towards unity. The result arrived at for the flow through a smooth pipe that a coefficient C is to be used with the slide rule in predicting the two phase pressure drop, now makes it possible to use the slide rule in calculating the pressure drop for rough pipes as well. With the corrections suggested by equations 9 and 10, and so long as there exists a coefficient C , it is always possible to use scales 12 a and b of the slide rule, though they are based on the assumption



* For Nombers between paranthesis see references.

liquid adjacent to the pipe wall is present. Even though the effect of the layer of liquid upon the cress section of the gas flow is small (I)* yet the pressure rise is very high. It is quite possible that there is a formation of waves at the interface that will make the tube appears rough to the gas. With this explanation in mind the two phase pressure drop for the smooth pipe is calculated with the suggested slide rule and the calculated value being based on the assumption of a smooth interface, is found less than the measured one. A coefficient C is introduced defined by the ratio of the measured two phase pressure drop to the calculated one by the use of suggested slide rule. This coefficient is in fact a measure of how much the shear stress at the interface have increased due to the action of gas upon the liquid to form waves or intrained liquid. The coefficient C is found to

Table (2)

I) Jhonson results : a = .0363 ft

No	Q_a ft^3/min	Q_w cusec	$\frac{dp}{dx}$ lb/ft^3	q_w	$\frac{Q_a}{Q_w}$	V_* ft/sec	C	Physical constants
I	5.7	.00432	7.5	2000	22	.I32	8.I	
2	I2.7	.00432	I3.6	2000	49	.207	5.96	$\frac{\rho_w}{\rho_a}$ = 875
3	44.7	.00432	36	2000	I72	.5I2	2.58	
4	I2.8	.0087	I8	4060	24.5	.26	4.7	
5	24.9	.0087	46.8	4060	48	.5	3.5	$\frac{\gamma_w}{\gamma_a}$ = .0557

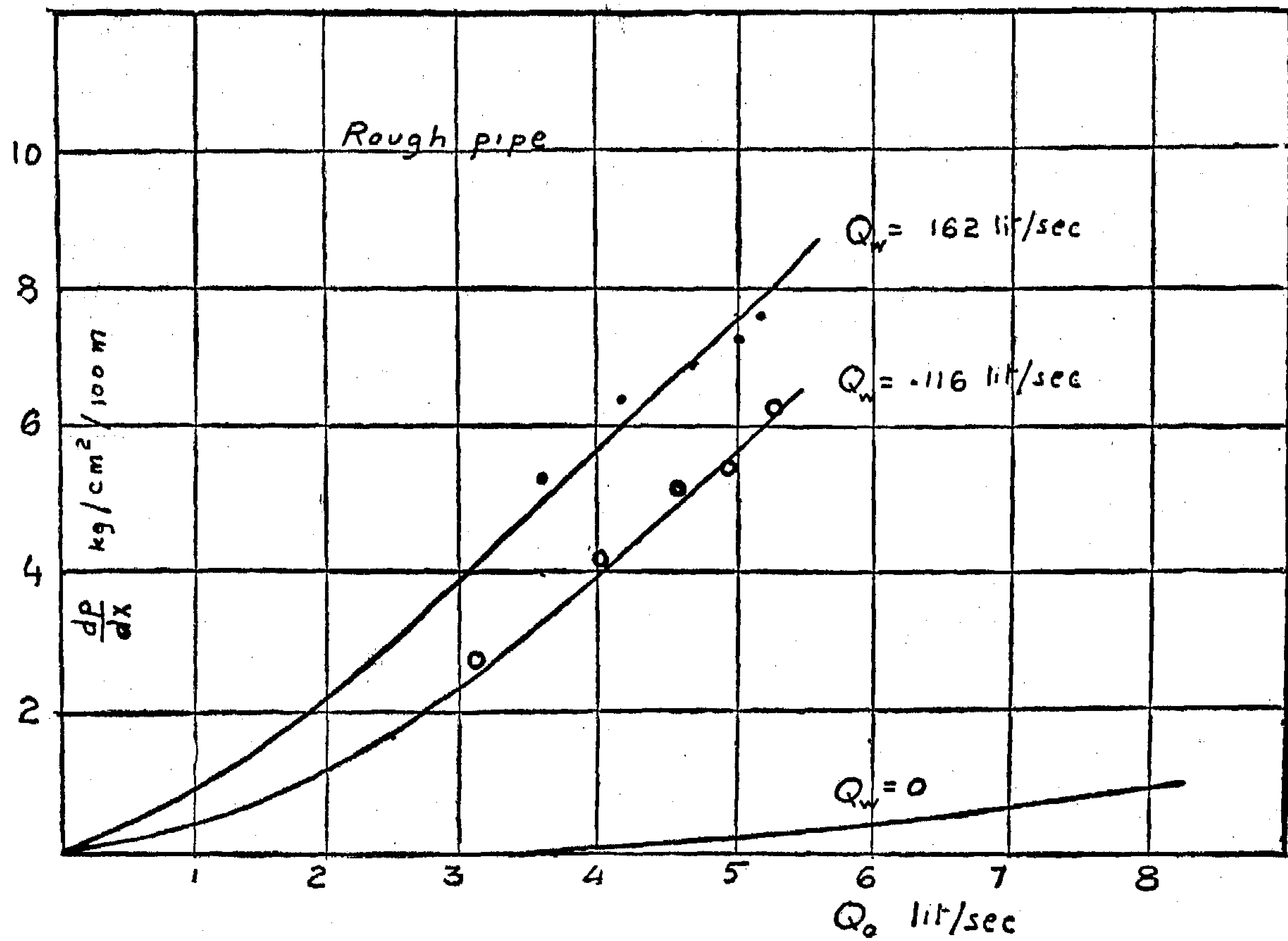
2) Kegel results : a = .04I6 ft

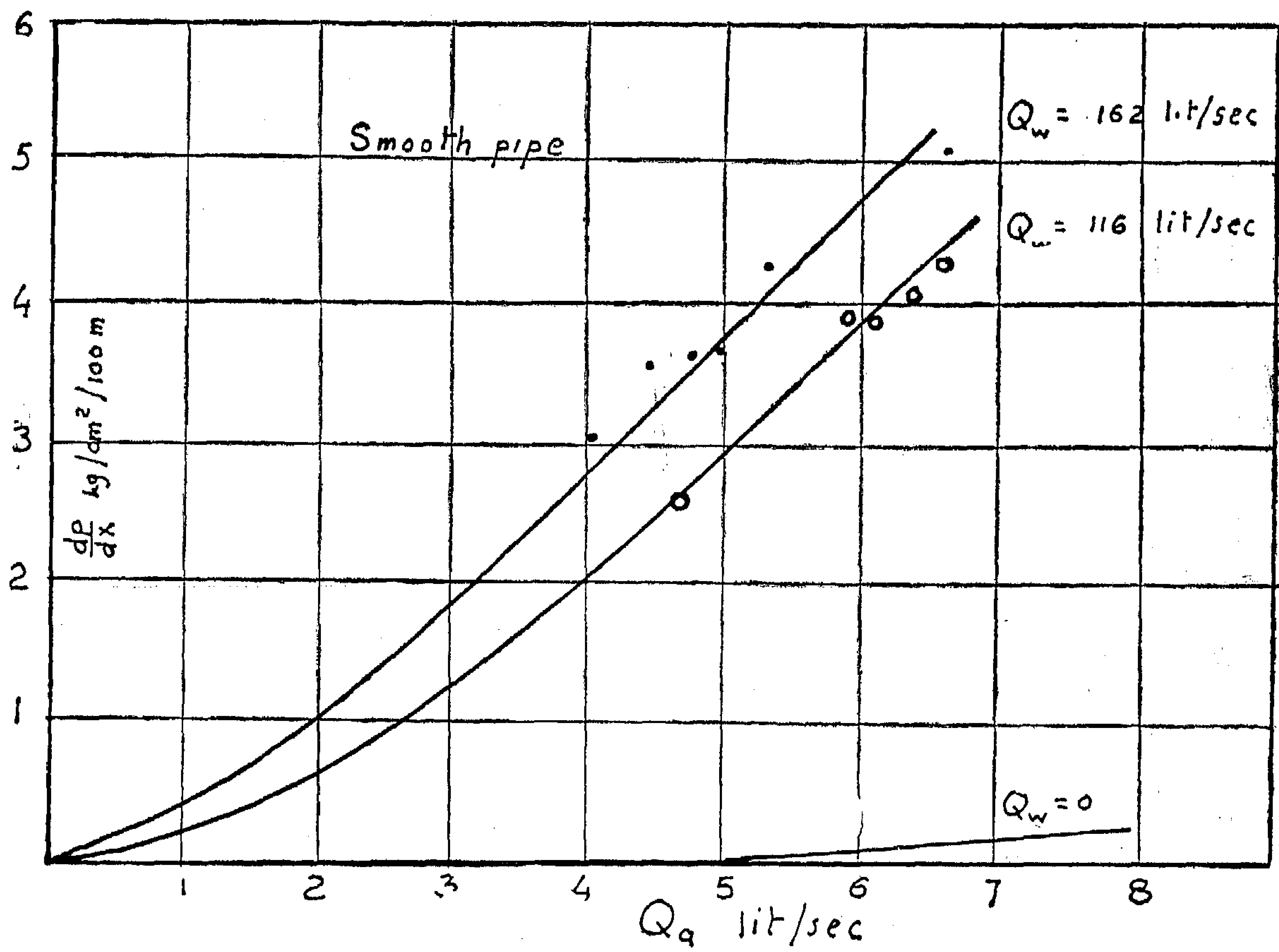
No.	W_a lb/hr	W_w lb/hr	$\frac{dp}{dx}$ lb/ft^3	q_w	$\frac{Q_a}{Q_w}$	V_* ft/sec	C	Physical constants
6	I45	300	8.84	762	420	.20I	2.4	
7	I65	300	I0.2	762	480	.228	2.I6	
8	I74	300	II.8	762	505	.234	2.36	$\frac{\rho_w}{\rho_a}$ = 870
9	I90	300	I4.3	762	550	.264	2.24	
I0	I40	700	I4.I	I778	I74	.2I8	3.26	$\frac{\gamma_w}{\gamma_a}$ = .037
II	6I	700	2.3	I778	756	.I29	I.5	
I2	89	I400	I0	3556	55	.I88	3.I	
I3	I0I	I400	I2.2	3556	62.4	.202	3.28	
I4	II7	I400	I5.2	3556	7I	.22	3.46	

3) Taylor results a = .0423 ft

No.	$W_a \times 10^2$ lb/sec	$W_w \times 10^2$ lb/sec	dp/dx psi/100ft	q_w	$\frac{Q_a}{Q_w}$	V_* ft/sec	C	Physical constants
I5	2.25	58.8	I5	3680	30	.I97	4.5	$\frac{\rho_w}{\rho_a}$ = 789
I6	2.52	32.5	8.86	2030	63	.I74	4.6	
I7	2.5I	77.I	9.09	2070	59.7	.I73	4.72	$\frac{\gamma_w}{\gamma_a}$ = .062

* For numbers between parant hesis see references


Rough pipe
10
8
6
4
2
dp/dx kg/cm²/100 m
Qw = 162 lit/sec
Qw = 116 lit/sec
Qw = 0
1
2
3
4
5
6
7
8
Qa lit/sec


Smooth pipe
6
5
4
3
2
1
dp/dx kg/cm²/100 m
Qw = 162 lit/sec
Qw = 116 lit/sec
Qw = 0
1
2
3
4
5
6
7
8
Qa lit/sec

RESULTS :

Observations taken for the flow of air and water in the smooth and rough pipes are shown in table (1). The results for the pressure drop calculated in kg/cm² /100 m length of pipe are plotted in fig. (3) — against the volumetric rate of flow of air for two constant water discharges Q_w = .116 and .162 lit / sec.

The curves for the whole air flow (Q_w = O) are plotted for both smooth and rough pipes. It is observed that the pressure drop for the annular two phase flow is much greater than that for a single phase flowing alone in the pipe for the same discharge of either gas or liquid phase concerned as shown in table (1). As the gas flow is increased for a certain liquid discharge, the two phase pressure drop increases. It is clear from the first glance to fig. (3) that there exists a tremendous rise of pressure along the same length of pipe once a thin layer of

Table (I)

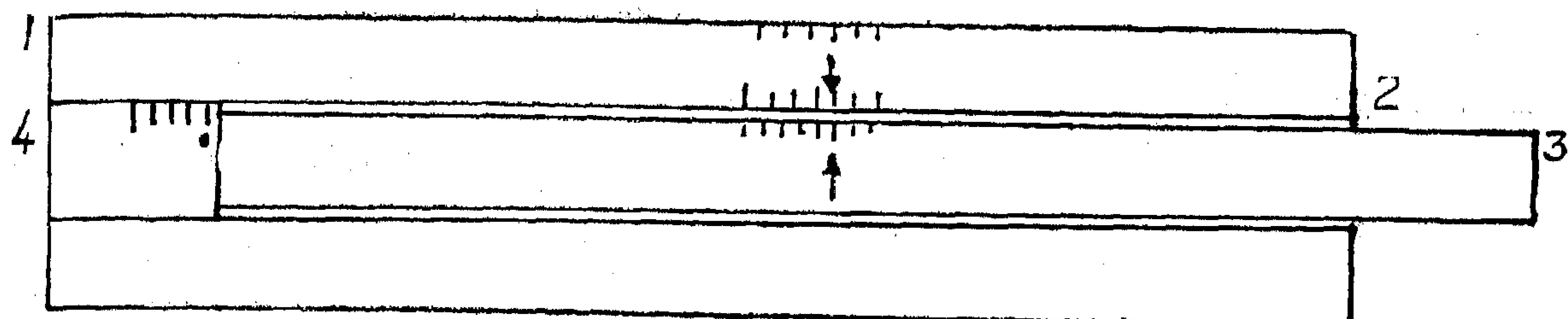
Test no.	Q_a lit/sec	Q_w lit/sec	$\frac{dp}{dx}$ *	q_w	V_* * m/sec	$\frac{Q_a}{Q_w}$	C	single phase $\frac{dp}{dx}$ air	single phase $\frac{dp}{dx}$ water
I	4.7I	.II6	2.59	I720	.0423	40.6	7.6	.I37	.08
2	5.I	.II6	4.I6	I720	.05	44.0	8.8	.I65	.08
3	5.9	.II6	3.97	I720	.0547	50.8	7	.2	.08
4	6.I	.II6	3.9	I720	.0562	52.6	6.6	.2I	.08
5	6.48	.II6	4.05	I720	.058	55.9	6.4	.237	.08
6	6.66	.II6	4.2	I720	.059	57.4	6.3	.252	.08
7	4.0	.I62	3.I	2400	.05I5	24.7	6.2	.I	.I45
8	4.49	.I62	3.59	2400	.054	27.7	6.5	.I23	.I45
9	4.8	.I62	3.7	2400	.0555	29.6	6.4	.I4	.I45
IO	4.92	.I62	3.72	2400	.056	30.4	6.2	.I44	.I45
II	5.35	.I62	4.I	2400	.059	33.0	6.I	.I68	.I45
I2	6.69	.I62	5.I	2400	.068	4I.3	5.8	.25	.I45
I3	3.03	.II6	2.99	I720	.047	26.I	7.I	.I32	.I58
I4	4.03	.II6	4.II	I720	.0535	34.7	9.5	.235	.I58
I5	4.23	.II6	5.52	I720	.0545	36.5	9.7	.26	.I58
I6	4.56	.II6	5.36	I720	.0565	39.3	8.9	.303	.I58
I7	4.97	.II6	5.5	I720	.0585	42.8	8.5	.357	.I58
I8	5.25	.II6	6.23	I720	.06	45.3	8.5	.4	.158
I9	3.59	.I62	5.25	2400	.0592	22.I	9.3	.I87	.306
20	3.92	.I62	6.58	2400	.06I	24.2	9.3	.222	.306
2I	4.09	.I62	6.6I	2400	.0623	25.2	8.9	.24	.306
22	4.7I	.I62	6.96	2400	.0673	29.I	8.I	.32	.306
23	5.07	.I62	7.34	2400	.0695	3I.3	8.0	.37	.306
24	5.27	.I62	7.45	2400	.0705	32.5	7.8	.404	.306

*
- Tests I - I2 are for the smooth pipe , I3 - 24 are for the rough pipe .
- The pressure drop dp/dx is in kg / cm² / I00 m length of pipe
V_* is calculated with the suggested slide rule

APPARATUS :

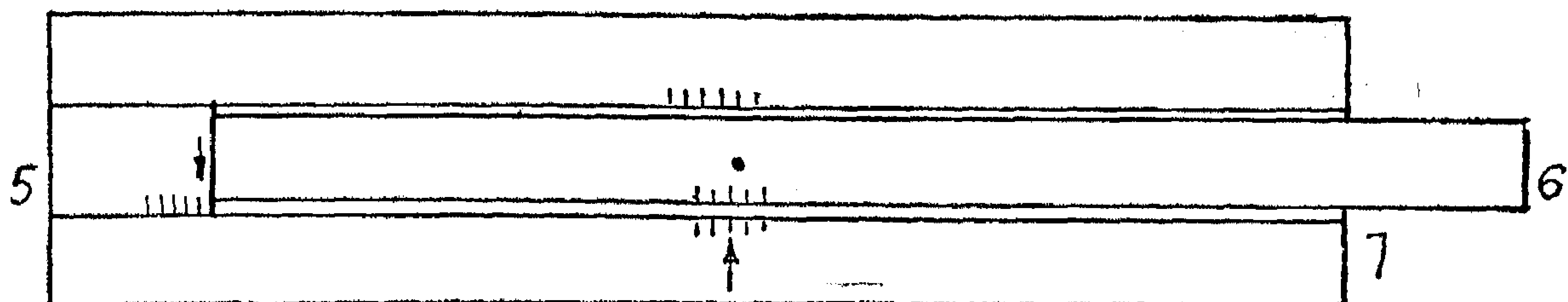
Two pipes were tested, one inch galvanised pipe which was considered smooth when the results for the pipe coefficient of friction for the flow of water coincided with the corresponding value calculated from Blasius equation.

The second is the same pipe artificially sand roughned with a relative roughness = .102 . That value was checked by calculating the pressure drop for the flow of air through this pipe and compairing it with experiment. The pressure drop is measured by a differential mercury manometer. The discharge of both air and water is measured by orifice meters. The supply of air is a reciprocating air compressor with a reservoir maintained at a constant pressure. The water supply is from an overhead tank.



a) Set scale 3 such that $\frac{V_* q}{\gamma_w}$ ↑ coincides with the value q_w ↓ on scale 2 Read $\frac{u_b}{V_*}$ on scale 1 and $\frac{b}{a}$, on scale 4

b) Set scale 6 on the value $\frac{b}{a}$ ↓ of scale 5 and with $\sqrt{\frac{\rho_w}{\rho_a}}$ ↑



on scale 7, read the value $\frac{V_*'}{V_*}$ on scale 6

c) Use scales 8,9,10,11,12 to determine $\frac{V_*' b}{\gamma_a} = \frac{\gamma_{*a}}{\gamma_w} \cdot \frac{\gamma_w}{\gamma_a} \cdot \frac{V_*'}{V_*} \cdot \frac{b}{a}$ ↑ and its corresponding value $\frac{u_m}{V_*'}$ ↓. Multiply by V_*'/V_*, add $\frac{u_b}{V_*}$ on the same scale and divide by $(\frac{b}{a})$. The result is $\frac{Q_a}{\pi a^2 V_*}$

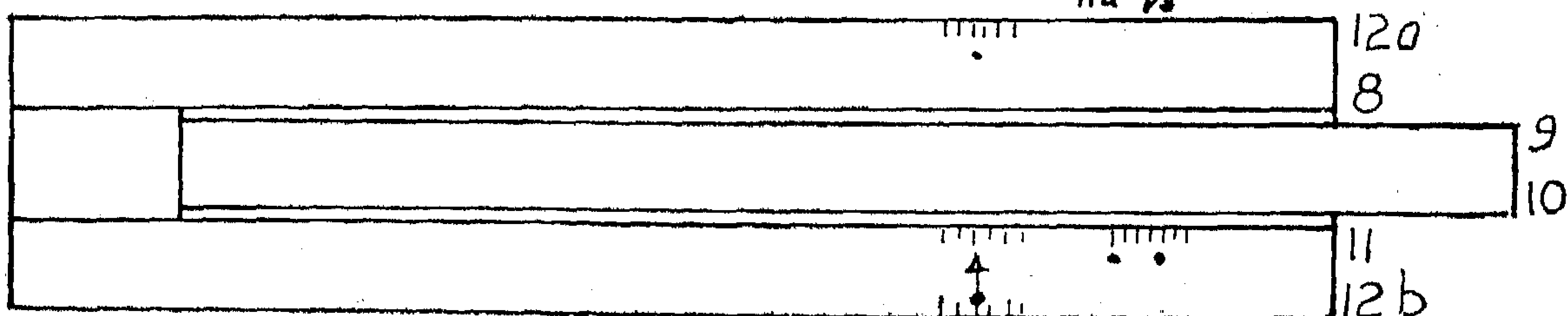


Fig. 2.

To use the result obtained from scale number 12 in this equation, we have to multiply u_m/V_*^{1} thus obtained by V_*^{1}/V_* and add u_b/V_* . previously obtained which if then multiplied by $(b/a)^2$ the result have to be equal to $Q_a/\pi a^2 V_*$ as given by equation (7).

Rough pipes :

To make use of scales number 1,2,3 and 4 constructed for a smooth surface in determining each of b/a and u_b/V_* for a rough surface we have from equation (4) for a smooth surface that

$$\left[q_w/\left(\frac{V_* a}{\nu_w}\right)\right]_S = \int_{0}^{\zeta/a} \left[C_1 + 5.75 \log\left(\frac{y}{a}\right) \right] d\left(\frac{y}{a}\right)$$

where C1 = 5.75 log $V_* a/\nu_w$ + 5.5; this is a constant for a certain value of $V_* a/\nu_w$

$$\left[q_w/\left(\frac{V_* a}{\nu_w}\right)\right]_S = C_1\left(1-\frac{b}{a}\right) + \int_{0}^{\zeta/a} \log\left(\frac{y}{a}\right) d\left(\frac{y}{a}\right) \qquad (8)$$

Since the distribution of velocity near a rough wall is given by :

$u/V_* = 5.75 \log Y/k + 8.48$

$$\left[q_w/\left(\frac{V_* a}{\nu_w}\right)\right]_R = \int_{0}^{\zeta/a} \left[C_2 + 5.75 \log\left(\frac{y}{a}\right) \right] d\left(\frac{y}{a}\right)$$

where C_2 = 5.75 log a/k + 8.48, this is a constant for a certain relative roughnees

$$\left[q_w/\left(\frac{V_* a}{\nu_w}\right)\right]_R = C_2\left(1-\frac{b}{a}\right) + \int_{0}^{\zeta/a} \log\left(\frac{y}{a}\right) d\left(\frac{y}{a}\right) \qquad (9)$$

compairing equations 8 and 9 we see that the ratio $q_w / \frac{V_* a}{\nu_w}$ for a rough pipe differs from a smooth pipe by the quantity

$$\left(1-\frac{b}{a}\right)\left(5.75 \log \frac{V_* k}{\nu_w} - 8.98\right)$$

Thus scale number 2 can be used for a rough pipe as well if we subtract from the parameter q_w for a certain value of $V_* a/\nu_w$ a term given by :

$$\frac{V_* a}{\nu_w}\left(1-\frac{b}{a}\right)\left(5.75 \log \frac{V_* k}{\nu_w} - 2.98\right)$$

To make use of scale number I of the slide rule for calculating the interfacial velocity in a rough pipe we have :

$$\left.\frac{u_b}{V_*}\right)_R = \left(5.75 \log \frac{a}{k} + 8.48\right) + 5.75 \log\left(\frac{\zeta}{a}\right) \qquad (10)$$

compairing equations 5 and 10 we see that u_b/V_* for a smooth pipe differes from that of a rough pipe by a term.

$$G = 5.75 \log \frac{a}{k} - 5.75 \log \frac{V_* a}{\nu} + 2.98$$

This will allow the use of scale number (I) for a rough pipe as well.

How to use the slide rule :

For the prediction of the pressure drop in a certain problem, the physical constants ϱ_w/ϱ_a and ν_w/ν_a are calculated together with the parameter $q_w = Q_w / 2\pi a \nu_w$; making use of scales 8,9,10 and 11 of the slide rule. Then proceed on by choosing a value for V_* calculate $V_* a/\nu_w$ and $Q_a/\pi a^2 V_*$ With a trial and error method one can arrive at the exact value of V_* by the help of the slide rule as follows :

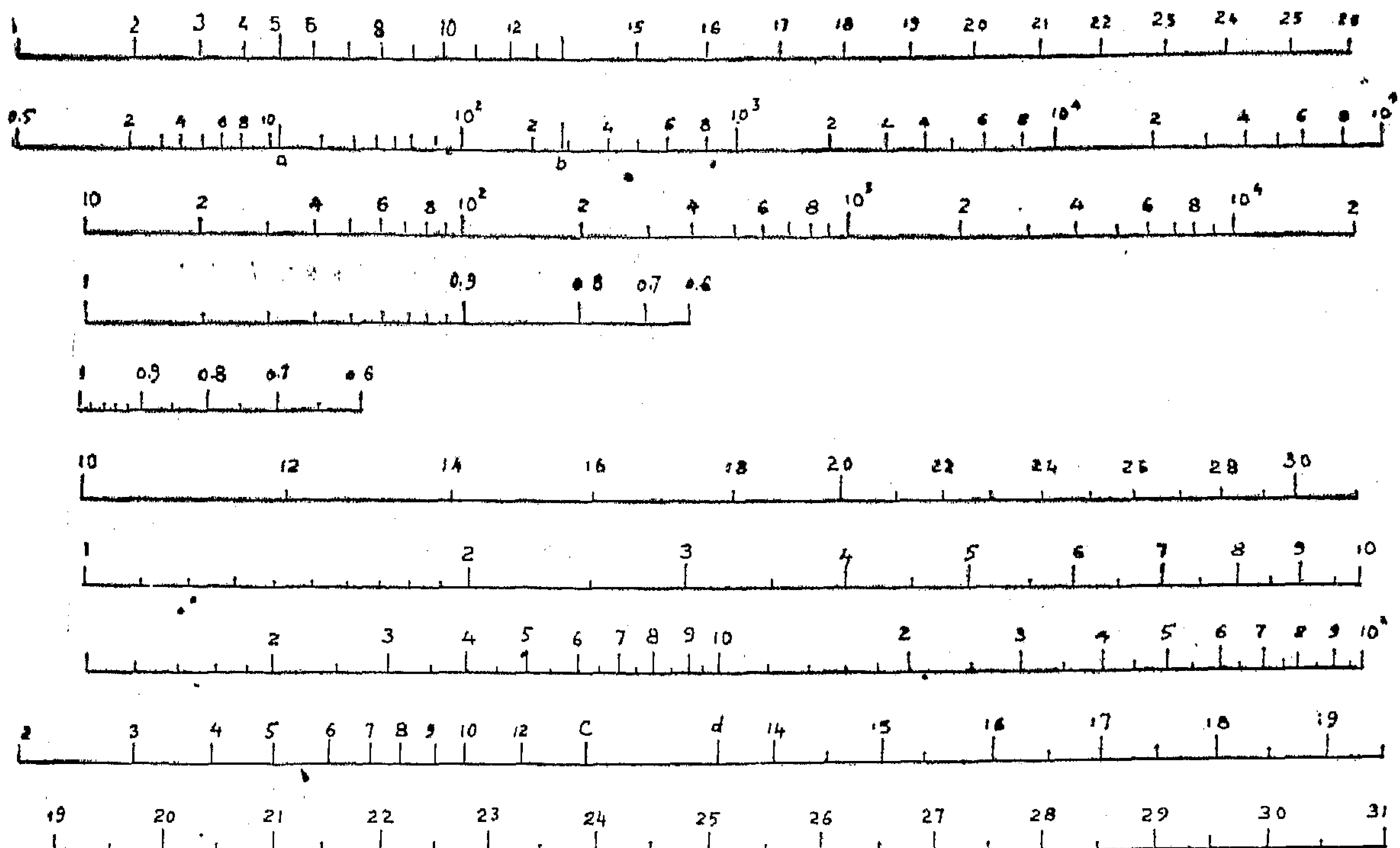
1) Set scale 3; fig. (2); such that the chosen value of $V_* a/\nu_w$ coincides with the calculated value of q_w on scale 2. Read u_b/V_* on scale I and b/a on scale 4

2) Set the sliding scale 6 on the corresponding value of b/a of scale 5 and with $\sqrt{\varrho_w/\varrho_a}$ on scale 7 read V_*^{1}/V_* on scale 6.

3) On the back of the slide rule, use scales 8,9,10,11 and 12 to determine $V_*^{1} b/\nu_a$ and its corresponding value of u_m/V_*^{1}

4) Multiply this result by V_*^{1}/V_* to get u_m/V_* and add to that u_b/V_* on the same scale then divide the result by $(b/a)^2$.

This value is $Q_a/\pi a^2 V_*$. If not, repeat with another V_* . The process is very easy by practice.



i.e. for each value of the ratio b/a and fixed density ratio ϱ_w/ϱ_a, the value of V_*'/a is known. Thus scales number 5, 6 and 7 are constrcuted to cover a range for

$\sqrt{\varrho_w/\varrho_a}$ between 10 and 30

ii) **For the gas core :**

If the mean velocity of gas in the core relative to the interface u_m is given by :

$$\frac{u_m}{V_*'} = 5.66 \log \frac{V_*' b}{\nu_a} + 1.99 \qquad (6)$$

then to reduce the variables to a common basic parameter for the calculations namely $V_* a/\nu_w$ we have to connect the characterising factor for the core to that one through the relation :

$$\frac{V_*' b}{\nu_a} = \frac{V_* a}{\nu_w} \; \frac{\nu_w}{\nu_a} \; \frac{V_*'}{V_*} \cdot \frac{b}{a}$$

for that, scales number 8,9,10 and 11 of an ordinary slide rule may be used to determine the value of V'_*/ν_a for a known value of $V_* a/\nu_w$. Scale number 12 which is fixed by equation (6) is now used to find the value of the corresponding u_m/V_*'

Scale 12 a is for values of $V'_* b/\nu_a$ up to 10^3 and scale 12 b for values ranging between 10^3 to 10^5. Although the flow of gas in the core is not likely to be viscous, yet it is beneficial to extend scale 12 a to cover the viscous flow region too. As

$$R_N = \frac{2 u_m b}{\nu_a} = \frac{V_*' b}{\nu_a} \; \frac{2 u_m}{V_*'}$$

∴ for the lower limit of turbulence R_N = 2800;

$$\frac{V_*' b}{\nu_a} \; \frac{u_m}{V_*'} = 1400$$

together with equation 6 gives a value of u_m/V_*' = 13.6. For the higher limit of laminar flow R_N = 2000, i.e. $(V_*'b/\nu_a).(U_m/V_*' = 1000$ and as $v_*'b/\nu_a = \frac{1}{4} - V_*'b/\nu_a$, then (u_m/V_*') = 15.8. These 2 limits are indicated on scales 12 a by points c and d. Below c ($V_*'b/\nu a$ = 63.2) the flow in the core is laminar whilest above d ($V_* b/\nu a$ = 103) the flow is turbulent.

As the discharge in the **gas** core is given by

$$Q_a = \pi b^2 \left(u_b + u_m \right)$$

$$\frac{Q_a}{\pi a^2 V_*} = \left(\frac{b}{a}\right)^2 \left(\frac{u_b}{V_*} + \frac{u_m}{V_*} \right) \qquad (7)$$

is important for the designer to be able to predict the pressure drop occuring during this two phase flow. Examples of such systems are numerous such as water steam mixtures in boilers, petroleum liquids and their vapours in tube stills, liquid vapour mixtures in refregiration systems and partial condensers in fractionation systems.

Among the many flow types of a gas and liquid in pipes, is the annular flow in which the liquid is confined to a thin annulus at the pipe wall while the gas flows in the core. To study the laws governing the motion of gas and liquid in this type of flow through pipes, is of special importance in various branches of industry. The field of annular flow is important in condensers, evaporators, reactors and steam lines. The main aim of this paper is to make use of the known equations for the single phase flow through pipes in constructing a slide rule to make easy the prediction of the pressure drop for the two phase annular flow in smooth or rough pipes.

THEORY :

The following treatement gives the base upon which the slide rule is constructed :

i) **For the liquid phase :**

If the thickness "t" of the liquid annulus is small with respect to the raduis a of ppe the liquid discharge / unit length of the pipe periphery $\frac{Q_w}{2\pi a}$ can be put in the form

$$\frac{Q_w}{2\pi a} = \int_0^t u\, dy \qquad (1)$$

where u is the velocity at a point distance y from the pipe wall. Introducing the liquid parameter q_w :

$$q_w = \frac{Q_w}{2\pi a \nu_w} = \frac{V_* a}{\nu_w} \int_0^{t/a} \frac{u}{V_*}\, d\left(\frac{y}{a}\right) \qquad (2)$$

For turbultent flow over a smooth boundary we have for the distribution of velocity in the liquid annulus at the pipe wall that :

$$\frac{u}{V_*} = 5.75 \log \frac{V_* y}{\nu_w} + 5.5$$

for values of $\frac{V_* y}{\nu_w} \geq 30$ i.e for $\frac{u}{V_*} \geq 13.95$

$$\frac{u}{V_*} = 5.75 \log \frac{V_* a}{\nu_w} + 5.5 + 5.75 \log\left(\frac{y}{a}\right) \qquad (3)$$

$$q_w = \frac{V_* a}{\nu_w} \int_0^{t/a} \left[\left(5.75 \log \frac{V_* a}{\nu_w} + 5.5\right) + 5.75 \log\left(\frac{y}{a}\right)\right] d\left(\frac{y}{a}\right) \qquad (4)$$

This equation gives the value of q_w for a certain value of $\frac{V_* a}{\nu_w}$ for different ratios (b/a) where b is the radius of gas core = a — t

Accordingly scales number 2, 3 and 4 of the slide rule are constructed fig. (I). (Scale 4 is placed in the recess under the sliding part.)

If we put y = t in equation (3), the velocity obtained is the interfacial velocity :

$$\frac{u_b}{V_*} = \left(5.75 \log \frac{V_* a}{\nu_w} + 5.5\right) + 5.75 \log\left(\frac{t}{a}\right) \qquad (5)$$

i.e. for every q_w there is a certain value for $\frac{u_b}{V_*}$ hence scale number (I) is fixed.

If the flow in the annulus is viscous i.e. $\frac{u}{V_*}$ is $\angle$ 5, we have for the distribution of velocity $\frac{u}{V_*} = \frac{V_* y}{\nu_w}$ that

$$q_w = \frac{1}{2}\left(\frac{V_* a}{\nu_w}\right)^2 \left(1 - \frac{b}{a}\right)^2$$, hence an extension for scale 2 is made to cover the viscous region of q_w below point "a" fig. (1). "a b" is a transition region and Values of q_w greater than "b" falls in the turbulent region.

If we consider the same pressure drop $\frac{dp}{dx}$ in both phases; the shear velocity at the interface V_*' is related to the shear velocity at the pipe wall V_* through the ratio $V_*'/V_* = \sqrt{\rho_w/\rho_a}\ \sqrt{b/a}$

ANNULAR TWO PHASE FLOW IN PIPES

By

Dr. M.F. ABDEL-AZIZ

SUMMARY :

This paper presents the idea of a slide rule that can be used for predicting the pressure drop for the annular two phase flow in smooth pipes. The use of the slide rule is extended also to the prediction of pressure drop for the two phase flow in rough pipes in which the ronghness is less than the thickness of the liquid film adjacent to the pipe wall. A pressure drop coefficient is introduced which is complimentary to the slide rule for predicting the pressure drop. This coefficient which is the ratio of the measured pressure drop to the calculated one by the slide rule is found to be a function of the air water dischage ratio and a liquid parameter. The results were correlated with other investigators. For predicting the pressure drop in rough pipes in which the wall roughness projects outside the liquid annulus into the gas core the slide rule was found useful although it was constructed on the base of the flow of the gas in a core with a smooth interface. The results obtained by the slide rule were found to match with experiment by using a different pressure drop coefficient.

NOMENCLATURE :

The following symbols are used during the paper :

a = raduis of pipe

b = raduis of gas core

c = coefficient

k = absolute roughness

q_w = liquid parameter

Q = discharge

R_N = Reynolds number in the gas core = $\frac{\varrho u_m b}{\mu}$

t = thickness of liquid annulus = a - b

u = velocity at a distance y from the pipe wall

u_b = interfacial velocity

u_m = mean velocity in the gas core relative to the interface

V_* = shear velocity at pipe wall $= \sqrt{\frac{dp}{dx} \cdot \frac{a}{2\varrho_w}}$

V_* = shear velocity at interfa ce $= \sqrt{\frac{dp}{dx} \cdot \frac{b}{2\varrho_a}}$

$\frac{dp}{dx}$ = two phase pressure drop / unit length of pipe

ϱ = density

ν = kinematic viscosity = μ/ϱ

subscript :

a = gas phase

S = smooth pipe

R = rough pipe

w = liquid phase

INTRODUCTION :

Many engineering problems involve the simultanous flow of a gas and liquid. In a number of engineering flow systems it

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الجهاز التنفيذى لمشروعات التعمير

يقصد بالتعمير فى معناه الحديث اعداد احدى المناطق ليحيا المواطنون بها حياة كريمة صحية فى مساكنهم ومرافقهم ومواقع انتاجهم حتى يتفرغ كل منهم ليعطى للبلد أقصى ما يستطيع اعطائه لأن خلفيات حياته مؤمنة ميسرة .

ومن هذا التعريف فان التعمير يكاد يشمل جميع أنشطة القطاعات المختلفة للدولة فى المنطقة التى يحتويها التعمير كالاسكان والصناعة والزراعة والري والكهرباء جنبا الى جنب مع خدمات التعليم والصحة والأمن والعدل وغيرها .

وكان من أولى المناطق التى تركز فيها التعمير، مناطق قنال السويس نظرا لأنها كانت احدى الأهداف الرئيسية التى صب عليها العدو الغادر نيرانه بلا تمييز فدمر منشأتها تدميرا .

ونستطيع من الجدول التالى الذى يوضح بعض الأمثلة للوحدات التى أصيبت فى بلاد القنال الكبرى وتحتاج الى اصلاحات وترميمات يضطلع بها الجهاز التنفيذى للتعمير أن تتصور ما لحق بتلك البلاد من دمار .

المنشـــأ	السويس	الاسماعيلية	بور سعيد	اجمالى
مـدارس	٤٢	٨٥	٧٠	١٩٧
مستشفيات	١٢	١٨	٦	٣٦
وحدات حكومية	٢١٢٦	٨١	٧٩٢	٢٩٩٩
وحدات اهالى سكنية	١٥٤٢٤	٥٣٢٤	٦١٤٧	٦٨٩٥

وتقوم خطة قطاع التعمير فى الوقت الحاضر على أساس تحقيق تحرك سريع نحو اعادة الحيـــاة الطبيعية لمناطق القناة فى أسرع وقت مستطاع . وفى نفس الوقت احداث تقدم ملموس نحو التطـور والتقدم لمستقبل تلك المناطق . وفى سبيل ذلك طرحت مسابقات عالمية تحقيقا للتكامل بين الأهداف القريبة المدى والأهداف البعيدة المدى .

وتستهدف تلك المسابقات دراسات عمليـات استصلاح الأراضى والسياحة والترفيه وانشاء المناطق الحرة وتسهيلات الموانى المختلفة والتنميـة الصناعية ودراسة وسائل النقل المختلفة من والى المناطق القنال .

وقد فازت ذلك البيوت التالية من بين ٤٨ بيتا عالميـا .

المنطقـة	اسم البيت الفائز	اسم الشريك المصرى	قيمة العقد	تاريخ بدا العمل الفعلى
السويس	Sir William Halcrow & p	حامد القداح وشركاه	٤٠٥٠٠٠ استرلينى + ١٥٠٠٠ مصرى	١٩٧٤/١٢/١
الاسماعيلية	Clifford & Partners	د. احمد محرم د. ميشيل باخوم	٤٧٠٠٠٠ استرلينى + ١٦٥٠٠٠ مصرى	١٩٧٤/١٢/١
بور سعيد	Bullen & Partners	د. وليم سليم حنا وشركاه	٣٨٥٠٠٠ استرلينى + ١٣٥٠٠٠ مصرى	١٩٧٤/١٢/١

وتقدر حجم استثمارات الخطة بادية الذكر بحوالى ٣ر٣ مليار جنيه موزعة كما يلى :

الاستثمار		**نوع النشاط**
٥٠٠	مليـون	استصلاح أراضى
٣٥٠	«	صناعات بترولية
٢٠٠	«	تنمية صناعية
٣٥٠	«	مناطق حرة
٢٠٠	«	موانى
٣٠٠	«	كهرباء
٣٠٠	«	نقل ومواصلات
١٠٠٠	«	اسكان ومرافق
١٠٠	«	تنمية سياحية
٣٣٠٠	مليون	

وتجرى وزارة التعمير الآن مفاوضات بين هيئة التنمية للامم المتحدة UNDP لتمويل دراسات التخطيط العام لمناطق قنال السويس .

وطبقا لموازنة عام ١٩٧٥ يبلغ ما يختص قطاع التعمير ٧ر٢٤٢ مليون جنيه موزعة كما يلى :

(بالألف جنيه)

بيـــان	محلى	اجنبى	جمـلة
مناطق القنال	١٤٠٤٠٠	٧٩٦٠٠	٢٢٠٠٠٠
منطقة القاهرة	٩٣٠٠	٦٠٠٠	١٥٣٠٠
منطقة الاسكندرية	٨٠٠	٠٠٠٠	٨٠٠
منطقة مطروح	٢٣٠٠	٠٠٠٠	٢٣٠٠
استثمارات اخرى	١٥٠٠	٢٨٠٠	٤٣٠٠
جمـــلة	١٥٤٣٠٠	٨٨٤٠٠	٢٤٢٧٠٠

ومن أهم ما تضمنته هذه الاستثمارات بخلاف أنشطة الاسكان والتى تشمل انشاء نحو ١٣ ألف وحدة سكنية جديدة ـ أنشطة الصناعة التى تضمنت اعادة تشغيل جميع المصانع التى كانت قد توقفت كمصنع السماد بالسويس وكمصنعى قنالكترون والترانزستور بالاسماعيلية وكجباسات البلاح ومصنع بورتكس للغزل والنسيج ببور سعيد .

وفى قطاع الرى والزراعة استهدف التعمير توسيع ترعتى الاسماعيلية وبور سعيد وتجفيف مساحات من البحيرة حول مدينة بور سعيد تقدر بنحو ٥٠ ألف فدان . وفى قطاع النقل والمواصلات تضمنت مشروعات التعمير اعادة تشغيل موانى السويس وبور سعيد وتوسيع الطرق الموصلة بين مدن القناة واعادة تشغيل خط سكةحديدبورسعيد الاسماعيلية وربط مدينة بور سعيد بخط حديدى جديد مع المنصورة .

وفى مدينة القاهرة استهدفت مشروعات التعمير النهوض بمشروعات المرافق كمياه الشرب والمجارى واستكمال العمل فى كوبرى رمسيس وتركزت مشروعات التعمير فى منطقة الاسكندرية فى تنفيذ خط مياه الشرب الخاص بمرسى مطروح وطوله نحو ٣٠٠ كيلو متر .

وبعد لقد سبق لنا أن قابلت مصر التحدى بالصمود . ثم جاء ٦ اكتوبر العظيم وعبرت مصر كلها ممثلة فى جيشها الباسل وحطمت خط بارليف .

ولا شك ان انتهاء الجـولة الأولى من معركة التحرير والنصر قد جعل شعب مصر العظيم يصمم على اعادة الحياة الطبيعية الى كل ما شوهته الحرب ويندفع فى تنفيذ خطته متحررا من كل روتين معتمدا على سواعد أبنائه المخلصين الذين يعطون بلا حدود .

المؤسسة المصرية العامة للطرق والكبارى

مرفق الطرق والكبارى من اهم المرافق التى تعتمد عليها الدولة فى تحقيق اغراض التعمير والنشاط التجارى والصناعى واستتباب الامن وتشجيع السياحة وتوفير مقتضيات الدفاع .

وتزداد اهميته فى الدول النامية اذ ترتبط شبكات الطرق ارتباطا وثيقا بخطط التنمية الاقتصادية فى قطاعاتها المختلفة من مشروعات صناعية وتعدينية واصلاح الاراضى . كما ان مدى كافية شبكة الطرق وامتدادها لتربط مناطق النشاط المختلفة بمراكز الاستهلاك وموانى التصدير تعتبر الركيزة الأولى لنجاح خطة التنمية .

ولا شك ان صدور قوانين يوليو الاشتراكية قد حقق بجانب الهدف العام من نقل أدوات الانتاج الى الملكية العامة للشعب ـ السيطرة الكاملة على هذا القطاع وتوجيهه لصالح خطة التنمية على هذا القطاع وتوجيهه لصالح خطة التنمية والربط بين الاستثمارات المطلوبة واحتياجات النقل للقطاعات الأخرى .

وقد انشئت المؤسسة المصرية العامة للطرق والكبارى عام ١٩٦٦ وأصبحت تضم جميع الأجهزة العاملة فى هذا القطاع المتكامل تحت ادارة عليا واحدة مما أمكن معه وبعد ممارسة فعلية حل كثير من المشاكل والمعوقات والاختناقات الادارية والتنسيق بين الطاقات المتاحة فى الأفراد والمعدات الذى كان مفتقدا نتيجة الانفصال بين جهاز التخطيط والتصميم والصيانة وبين جهاز التنفيذ ممثلا فى شركات القطاع العام .

وقد تحدث المهندس سليمان متولى رئيس مجلس ادارة المؤسسة عن التطور الذى تم فى المؤسسة والوحدات الاقتصادية التابعة .

اولا ـ المؤسسة :

اعادة التنظيم وتحديد الاختصاصات

أمد تنظيم جديد يحدد بوضوح اختصاصات ومسئوليات وسلطات كل فرد فيه وتهيئة افضل ظروف العمل وفى نفس الوقت يضع أمام الادارة العليا مقاييس لتقييم أداء العاملين .

تطور التصميم والمواصفات

وضعت قواعد جديدة للتصميم الهندسى للطرق بدرجاتها المختلفة روعى فيها الموازنة بين الاحتياجات الفعلية للظروف المحلية والقواعد المتبعة عالميا دون الاخلال بأمان المرور على الطرق .

ـ وضعت خطة علمية لحصر المرور للحصول على بيانات دقيقة عن حجم المرور وكثافة وتركيب وحداته .

ـ وحدث تطور سريع فى أساليب التصميم الانشائى للطرق يعتبر انتقال حقيقى من مرحلة تعتمد اساسا على الخبرة العملية الى مرحلة جديدة تعتمد على أسس نظرية وعملية سليمة يمكن تطبيقها بنجاح فى كافة الظروف .

ـ وقد استخدمت المؤسسة الحساب الآلى فى تصميم الطرق لأول مرة عندما أسند اليها اعداد وتصميم عدد كبير من مشروعات الطرق بليبيا وما كانت تستلزمه من عمليات ضخمة فى مدد قصيرة نسبيا . وقد اشترت المؤسسة فعلا مجموعة متكاملة من برامج تصميم الطرق فى جميع مراحلها من وزارة النقل بلندن .

ـ صدرت اول مواصفات قياسية للطرق عام ١٩٥٦ وكان من الضرورى تطوير هذه المواصفات لتتمشى مع التقدم العالمى فى صناعة الطرق وتم اصدار مواصفات عام ١٩٦٧ والحق بها الاختبارات القياسية وجارى حاليا طبع مواصفات جديدة .

تطوير اعمال التنفيذ

ـ أصبح الفيصل النهائى فى تقرير جودة التنفيذ هو نتائج الاختبارات فى المعمل وفى الغيط ، لذلك طورت المؤسسة المعامل التابعة للشركات وكذا معامل الاختبارات بالمناطق الاقليمية للمؤسسة والمعامل المركزية واضيف لكل منها واجبات محددة لتعطى صورة واضحة لمستوى التنفيذ فى كافة مراحله .

ـ أعدت خطة لاعمال التحسينات مع عمليات الصيانة الكبيرة يتم تنفيذها تباعا ضمن عمليات الصيانة الكبيرة توفيرا للنفقات وتشمل رصف الاكتاف لبعض الطرق الرئيسية واستكمال التقاطعات .

تطوير نظام الصيانة الدورية للطرق

لم يكن نظام صيانة الطرق المتبع من قبل مجديا لعدة أسباب أهمها تركيز امكانيات الصيانة من معدات ومواد وأفراد فى مقار المناطق أو الهندسات وكذا شيوع المسئولية ووجود عجز فى المعدات .

وقد أعد نظام جديد — تم تنفيذه فعلا — يعتمد على اللامركزية الكاملة وتحديد المسئوليات . فقسمت كل منطقة من المناطق الثمانية التابعة للمؤسسة الى عدد من الوحدات كل منها مسئول عن صيانة من ٣٠٠ — ٥٠٠ كيلومتر ، كما قسمت كل وحدة الى عدد من الفروع كل منها مسئول عن ١٠٠ — ١٥٠ كيلومتر من الطرق المرصوفة وتم تزويد الوحدات والفروع بالأفراد والمعدات والمواد اللازمة — كما تم تنفيذ الانشاءات الثابتة الخاصة بها — وحقق النظام الجديد نجاحا تاما .

تطوير مناهج التدريب

يعتبر التدريب الدورى المنتظم اهم وسائل رفع الكفاية الانتاجية للأفراد واكسابهم المهارات وتزويدهم بما يستجد من العلوم الحديثة نظريا وعلميا .

وقد تم تعديل المناهج التدريبية تعديلا جذريا استلزمه وضع المؤسسة الجديد بعد ضم الشركات اليها — كما اعدت بعض المناهج المتخصصة بالاستعانة ببعض الخبرات الخارجية — واصبح مركز التدريب التابع للمؤسسة يستقبل عددا كبيرا من المدربين داخل وخارج الجمهورية لا سيما الدول العربية .

خطة البحث العلمى وتطبيقاته

ايمانا من المؤسسة بأهمية البحث العلمى فى صنع التقدم فقد تضمن التنظيم الجديد لها ادارة عامة للبحوث الفنية قامت باجراء عدد من البحوث بهدف حل المشاكل التطبيقية ورفع مستوى التصميم والتنفيذ طبقا لخطة خمسية .

ومن أهم مساعدات البحوث المراجع المتخصصة والأجهزة الدقيقة المتقدمة لذلك الحق بالمركز مكتبة ترد اليها بصفة دورية ومنتظمة أحدث الكتب والنشرات العلمية من سبعة وعشرين هيئة وجامعة ومركز بحوث فى الخارج ، كما دعمت المعامل المركزية للاختبارات بعدد من اجهزة البحوث الدقيقة والمستوردة من الخارج .

ثانيا — تطوير العمل بالشركات :

التنظيم المالى والمخازن والورش :

تم تطبيق النظام المحاسبى الموحد بجميع الشركات مما استلزم تغيير المجموعات الدفترية كما تم وضع تنظيم لدورة المستندات الحسابية بما يحقق الرقابة الداخلية ، ومن أهم الاجراءات التى تمت والتى كانت متراكمة منذ التأميم هو مراجعة وتصفية أرصدة المدينين والدائنين .

وتم انشاء اقسام للتكاليف بالشركات وتقوم بدور هام فى دراسة تكاليف الانتاج لمختلف بنود الأعمال .

وقامت جميع الشركات بانشاء مبانى وتجهيزات جديدة للمخازن مع ترتيب وتصنيف المخزون السلعى على أسس سليمة واعد نظام محكم للمرتجع مما أدى الى خفض كبير فى نسبة العجز والفاقد والراكد .

وقد انشأت الشركات ورش جديدة دعمت بالعدد والآلات بهدف الوصول فى أعمال الاصلاحات الى الاكتفاء الذاتى تدريجيا مع الارتفاع بكفاءة ودقة عمليات الاصلاح .

نظام الحوافز :

ان أساس نظام الحوافز هو ربط الأجر بالانتاج بحيث لا يصرف الا نظير زيادة حقيقية فى الانتاج .

وقد توسعت الشركات فى تطبيق هذا النظام على أساس معدلات عادلة للانتاج وضعتها مجالس ادارة الشركات بنفسها وحقق هذا النظام وفرا فى التكاليف واختصار مدد التنفيذ المقررة .

مسئولية التنفيذ :

تحتاج أعمال الطرق الى دقة متناهية فى تنفيذها وتتسم بعض مراحلها بالحساسية الفائقة فى خواصها . لذلك يمكن تلافى معظم أسباب التلفيات التى تحدث فى الطرق بزيادة العناية فى التشغيل والاهتمام بضبط الماكينات لذلك اتخذت المؤسسة عدة قرارات فى هذا الشأن لتتحمل الشركات مسئولياتها الكاملة عن التنفيذ .

خفض التكاليف :

ان من أهم واجبات القطاع العام فى ادارته للمشروعات الاقتصادية مراقبة تكاليف الانتاج وضبط المصروفات

وقد اولت المؤسسة هذا الموضوع عناية كبيرة بعديد من الدراسات والاجراءات اهمها الآتى :

اعداد تكاليف نمطية للاعمال :

أعدت الدراسة الأولى عام ١٩٦٥ وروجعت وعدلت عام ١٩٧٢ وتعتبر الأسعار النمطية هى الحد الأعلا الذى يجب عدم تجاوزه سواء للأعمال التى تسند بمناقصات أو ممارسات أو أوامر تكليف .

ـ ضبط استهلاك المواد وتحديد معدلاتها :

تمثل اسعار المواد فى عمليات الطرق حوالى ٦٠٪ فى المائة من اجمالى قيمة العملية لذلك كان الاهتمام بالحد من استخدامها فيما يزيد عن المعدلات المتوسطة وقد بدىء ببند الوقود باعتباره من المواد الاستراتيجية الهامة وقد تم وضع معدلات للاستهلاك لا يجوز تجاوزها طبقا لاحصائيات فعلية مع الاسترشاد بالمعدلات التى وضعتها شركات صناعة معدات الطرق ، وجارى وضع معدلات لاستهلاك المواد الأخرى ودراسة مصادر العجز بها .

ـ ضبط العمالة :

من أهم مقومات المشروعات الاقتصادية أن تكون العمالة مناظرة تماما لحجم العمل المطلوب لمعدلات آداء عادلة .

لقد عالجت المؤسسة وضع طاقات المقاولات وما يتميز به من موسمية بعض الأعمال ووجود أعمال فرعية لا تدخل فى النشاط الأساسى للشركات ـ بأن استخدمت ثلاثة أنواع من العمالة هى العمالة الدائمة والعمالة المؤقتة وعمالة التراحيل ويثبت النوع الأول حسب المعدلات الوظيفية المقررة أما النوعين الثانى والثالث فيتغير ارتفاعا وانخفاضا مع حجم الأعمال بحيث تكون فى حدود عنصر العمالة المتداخل فى تحليل الأسعار النمطية .

ـ التصنيع المحلى للمعدات :

ان قيود الاستيراد من بلاد العملات الحرة دفعت الشركات الى بذل محاولات جدية للتصنيع المحلى للمعدات انتهت بأن امكن تصنيع معظم أجزاء محطات خلط الأسفلت على الساخن وبلغت تكاليفها فى المتوسط فى حدود ٥٠ فى المائة من قيمة مثيلاتها المستوردة .

ـ الاستفادة القصوى من الطاقات المتاحة والتدعيم بطاقات جديدة :

تم عمل حصر للمعدات المملوكة للشركات وما يطرا عليها من تغييرات بالاضافة والحذف وكذا حالتها وأعمارها والامكانيات المتاحة لاصلاحها وعلى ضوء ذلك تم تحديد طاقتها الانتاجية العملية بعد تقسيمها الى مجموعات متكاملة ـ وتقرر فى نهاية كل عام الكفاية الانتاجية بمقارنة الإنتاج الفعلى بالمقرر .

فتح مجالات انشطة متنوعة :

لقد رؤى حتى لا تواجه الشركات بوجود طاقات معطلة بها فى بعض السنوات التى تنكمش فيها مشروعات الطرق ـ فتح مجالات فى اعمال تخصصية غير متوفرة فى كثير من الشركات العاملة فى قطاع المقاولات بما يكفى لاستيعابها ومعظمها كان يسند لشركات أجنبية مثل مشروعات الموانى وكبارى النيل والكبارى العلوية والأعمال المدنية الكبرى (الاهوسة ومحطات الطلمبات) .. الخ .. وقد تكونت بشركة النيل العامة للطرق والكبارى خبرات واسعة فى مثل هذه المشروعات وآخرها كوبرى النيل عند دمياط الذى تقوم الشركة حاليا بتنفيذه .

(أ) بالنسبة للنشاط الخارجى للمؤسسة :

امتد نشاط المؤسسة للعمل كبيت استشارى فى الخارج وقد اسندت وزارة الأشغال السودانية للمؤسسة دراسة واعداد أربعة مشروعات للطرق للاعلان عنها فى مناقصات عامة وقد تمت بأكملها وسلمت وثائقها للحكومة السودانية . ويبلغ مجموع اطوالها ١٠٥٠ كم وتكاليفها ٢٦٣٠٠٠ جنيه استرلينى حسابى .

كما أسندت وزارة المواصلات الليبية للمؤسسة ثلاثة عشر مشروعا للطرق والكبارى والمطارات لاعداد المباحث والدراسات اللازمة لاعلانها فى مناقصات عالمية أو استعمالها من الشركات التى قامت بتنفيذها ، وتم اعداد هذه المشروعات التى يبلغ تكاليفها حوالى ١٫٥ مليون دينار ليبى فى المواعيد المحددة لها .

(ب) الشركات التابعة :

١ ـ أسند لشركة النيل العامة للطرق والكبارى عمليتى انشاء ورصف طريق براك ـ أدرى وطريق سبها ـ مرزق ووصلاتها ٣٢٠ كم بالجمهورية العربية الليبية بمبلغ حوالى ١٢ مليون جنيه ليبى ومدة العمليتين ثلاثين شهرا وتقدم سير العمل بالعمليتين مطابق للبرامج المقررة .

كما أسند للشركة أخيرا بأمر تكليف عملية رصف طريق مرزق ـ المكنوسه بطول ١١٠ كم وبتكاليف قدرها ٣٨٥٠٠٠ دينار ليبى وذلك نتيجة لما لمسته الحكومة الليبية من كفاءة الشركة وتنفيذها للأعمال طبقا للمواصفات وعلى أعلى درجة من الجودة وفى المواعيد المقررة .

٢ ـ كما رست على شركة النيل العامة لانشاء الطرق عملية انشاء ورصف احدى الطرق بالمملكة العربية السعودية تبلغ تكاليف انشاؤه حوالى ٤٠ مليون ريال سعودى وستبدأ الشركة فى العمل قريبا .



انطلاقة عظيمة للقضاء على أزمة الإسكان

المقاولون العرب

«عثمان أحمد عثمان وشركاه»

توفر لك المسكن المناسب بعد أن تدفع مقدم جنيه ... فقط

١٥٠٠	جنيها مصريا	أو	٤٠٠٠	دولار	للإسكان المتوسط
٣٠٠٠	« «	«	٨٠٠٠	«	للإسكان فوق المتوسط
٥٠٠٠	« «	«	١٥,٠٠٠	«	للإسكان الفاخر

بادر بالدفع قبل نهاية مارس ١٩٧٥

فى بداية اللقاء ، قال لى : قبل كل شىء هناك حقيقة هامة أحب أن أضعها أمام كل الأعين ، لأنها تمثل منطلقات العمل عندنا وهى اننا نبذل من أجل حركة البناء والتشييد فى الوطن العربى من الجهد والعرق والكفاءة على نحو ما نبذل من أجل هذه الحركة فى الداخل . وهذا عن ايمان عميق بأن تحقيق التقدم للامة العربية كلها . ومن موقعنا هذا فقد شاركنا فى تنفيذ عديد من المشروعات الهامة والحيوية فى مختلف الدول العربية الشقيقة وما زلنا نحمل أمانة هذه الرسالة ونعطى لها كل الامكانيات والخبرة والكفاءة الفنية لتكون على أرقى المستويات العالمية . ولدينا شهادات الخبراء العالميين بأن « المقاولون العرب » قد وصلت الى مستوى المنافسة العالمية ، وأنها قد حققت تقدما مذهلا فى مجال البناء والتشييد .. وفى تقديرى أن هذا الدور هو امتداد لتاريخنا العظيم فى هذا الميدان ، فالفراعنة قد بنوا للخلود ، ونحن اليوم نبنى للحياة والمستقبل ومن أجل الخير والسلام .

والكلمات على لسان **المهندس محمد عصام عباس** مدير عام مشروع ١٠,٠٠٠ وحدة والمسئول عن تنفيذه وموضوع اللقاء هو التعرف على المشروع كما وكيفا .. وقد بادرنى سيادته قائلا : كلنا نعلم ما نعانيه من تفاقم أزمة الاسكان وزيادة حدتها يوما بعد يوم حتى أصبح المسكن المناسب ، طلب من العسير تحقيقه . وهذا كله يعود للزيادة الهائلة فى عدد السكان من سنة الى أخرى مع قلة اقامة مساكن لامتصاص هذه الزيادة فى الأفراد فكان لابد أن يتأزم الموقف وتزداد مشكلة الاسكان حتى أصبحت من العلامات المظلمة على طريق التقدم الحضارى ولو تركت المشكلة دون حل لأصبحت كارثة يستحيل حلها .. وعلى ذلك عقدت مؤتمرات وتعددت لجان وظهرت مقترحات وتوصيات ولكن الوقت يمضى وتزداد المشكلة .. بل وتتعقد .. وتتزايد احتياجات الجماهير ومطالبهم .

وادراكا كاملا .. واعيا ومسئولا من **المقاولون العرب** ((**عثمان أحمد عثمان وشركاه**)) تضع كل ذلك نصب أعينها وتتحرك بوعى ايجابى نحو أهداف هـذه المرحلة تعميرا وتحريرا وبناء لتشارك بعمق فى بناء القوة الذاتية لمصر قادرة ومتجددة . ومن هـذا المنطلق توجت الشركة أعمالها العظيمة بأن واجهت المشكلة بعد ان رات أن هذا هو الحل الأمثل للقضاء على المشكلة التى وقفت تهدد كل من يحـاول أن يقترب منها . وأن مشروع الـ ١٠٫٠٠٠ وحـدة سكنية التى بدأته الشركة سيقع فى مناطق متفرقة فى أنحاء القاهرة الكبرى علاوة على اختلاف نوعياتها للوفاء بجميع الاحتياجات : من اسكان متـوسط ، فوق المتوسط ، الفاخر .

وقد روعى فى مشروع الـ ١٠٫٠٠٠ وحـدة سـكنية توفير مساحات كبيرة من الأراضى فى كل منطقة بحيث تكون المنطقة حيا سكنيا متكاملا يضم جميع المرافق والخدمات تحقيقا للاكتفـاء الذاتى للمنطقة وضمانا لقيام مدن عصرية متـكاملة وحتى لا تطغى المكاتب التجـارية .. ومكاتب الشركات الزاحفة الى مصر فى عصر الانفتاح الاقتصادى عـلى المناطق المزدحمة بالسـكان مما يزيد من أزمات الاسكان ومشاكل المواصلات فقد روعى أن يشـمل التخطيط بعض البنايات لتكون مقارا لهذه الشركات والمكاتب .. وسوف تملك هذه المبـانى للشركات والمكاتب الأجنبية بالعملات الصعبة التى سـوف يستخدمها ((**المقاولون العرب**)) فى اسـتيراد المواد والتجهيزات اللازمة لعمليات البناء والانشاء حتى يتم المشروع دون أن يؤثر على خطط الاسكان والتعمير فى الدولة ودون ارهاقها بطلب عملات صعبة لاستيفاء احتياجاتنا من المواد والتجهيزات المطلوب استيرادها من الخارج .

ومدة تنفيذ المشروع ٧ سنوات ينتهى خـلالها انشاء الـ ١٠٫٠٠٠ وحدة سكنية وقد تم فعلا تجهيز مسطحات خمس مناطق وهى : ـ

المنطقة الأولى (الميرلاند بمصر الجديدة) .

وسيبدأ العمل فيها فى منتصف عـام ١٩٧٥ ومسطحها ١٧ ألف متر مسطح وسـيكون بها حوالى ٤٠٠ وحدة سكنية من النوع الفاخر .

المنطقة الثانية (أرض أغا خان عـلى كورنيش النيل) .

ومسطحها ٤٠٫٠٠٠ متر مسطح وتسع ١٥٠ وحدة سكنية من النوع فوق المتوسط وسيبدأ العمل فيها فى نهاية سنة ١٩٧٥ .

المنطقة الثالثة (جاردن سيتى) .

ومسطحها ٢٫٠٠٠ متر مسطح وسيتم فيها انشاء ٥٠ وحدة سكنية من النوع الفاخر وسيبدأ العمـل فيها فى أول عام ١٩٧٦ .

المنطقة الرابعة (المعادى على كورنيش النيل)

ومسطحها ١٧٥ ألف متر مسطح وتشمل ٢٠٠٠ وحدة سكنية من الأنواع الثلاثة علاوة على أنها ستكون مدينة متكاملة بها كل المرافق والخدمات وسـيبدأ العمل فيها فى النصف الأخير من عام ١٩٧٦ .

المنطقة الخامسة (بجوار الأهرام بالجيزة) .

ومسطحها ٢٨٥ ألف متر مسطح وسيتم فيها انشاء ٣٥٠٠ وحدة سكنية من الأنواع الثلاث كمـا أنها ستكون مدينة متكاملة تضم جميـع المرافق والخدمات وسيبدأ العمل بها فى النصف الثانى من عام ١٩٧٧ .

وجارى اختيار باقى مناطق المشروع حتى ينتهى فى الموعد المحدد .

وايمانا من **المقاولون العرب** ((**عثمان أحمد عثمان وشركاه**)) بأهمية الدراسة والابحاث فى دولة العلم والايمان ... فقد أجـريت مسابقة بين المكاتب الهندسية المحلية والأجنبية لتصميم المنطقة الأولى من المشروع وهى ((الميرلاند)) وقد تقدم للمسابقة ٢٢ مكتبا هندسـيا .. وعرضت التصـميمات والدراسات على هيئة تحكيم مكونة من السادة :

الأستاذ الدكتور أحمد محرم

الأستاذ الدكتور حلمى الخولى

الأستاذ الدكتور يوسف شفيق

المهندس مصطفى شوقى

المهندس صلاح حسب الله

المهندس حسن ناصف

المهندس محمد عصام عباس

وأسفرت نتيجة التحكيم عن الآتى : ــ

الجائزة الأولى وقدرها ٥٠٠٠ جنيه فاز بهـا مكتب :

الدكتور مهندس رأفت الزغبى

المهندس عبد الحميد نوفل

المهندس صلاح عبد الرحمن

المهندس حامد شلبى

المهندس مصطفى رزق

الجائز الثانية وقدرها ٣٥٠٠ جنيه وفاز بهـا مكتب : ــ

الدكتور مهندس محمد سامى الشافعى

الجائزة الثالثة وقدرها ٢٠٠٠ جنيه وفاز بهـا مكتب :

المهندس نادر توفيق

وثلاث جوائز تشجيعية لكل من :

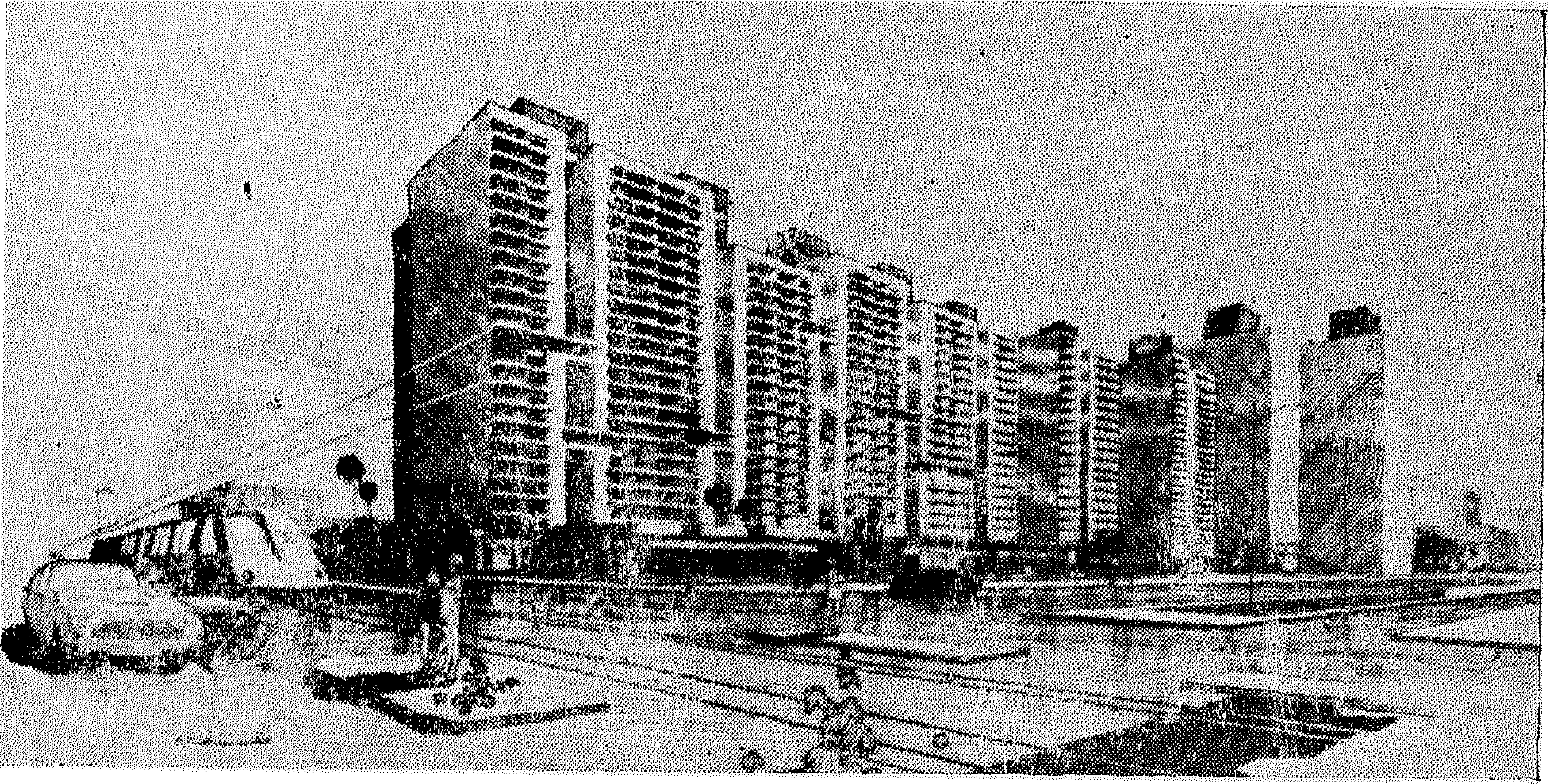
مكتب المهندسان محب ابراهيم ويسرى فـؤاد والمهندس يحيى حمودة والمكتب اليونانى .

ولما كان المشروع يهدف أصلا الى حل جزء من مشكلة الاسكان فى مصر فان استراتيجية التنفيذ تهدف الى انهائه فى فترة وجيزة ليوفر عدداً من الوحـــدات السكنية فى وقت واحد مما سيؤدى الى زيادة نسبية فى العرض وبذلك تقل حدة الطلب أو تخف حـــدة الاندفاعات الحالية التى فرضت مبالغ ضخمة على المواطنـين للحصـول على المسـكن .. أى أن التأثير غير المباشر قد وضع فى الحسبان وستحقق نتيجـة للامكانيات الضخمة والمتوفرة للمشروع .

ولقد كان الهدف من المشروع وما زال هو توفير المسكن الملائم للمواطن المصرى علاوة على أن المصريين المقيمين فى الخارج حق الحجز استـجابة لرغباتهم وواجبا على بلدهم فى توفير المسكن اللائق لهم .

أما بالنسبة للاشقاء العرب والمستثمرين الأجانب فهم لا يدخلون على الاطلاق فى منافسه مع المواطن المصرى الذى سيقام المشروع له أساسا . وعلى ذلك ستخصص نسبة محددة لهذه الفئات للحاجة للعملات الصعبة لشراء مستلزمات البناء من أجهزة ومواد . وحتى لا يؤثر المشروع على خطة الدولة بالنسـبة لمشروعات الاسكان الأخرى .





وبالنسبة للحصول على مسكن من هذا المشروع فقد قال السيد المهندس محمد عصام عباس .. لقد حددنا مقدم الحجز ليكون كالآتى :

بالنسبة للاسكان المتوسط فهو ١٥٠٠ جنيها مصريا أما بالنسبة للمصريين العاملين فى الخارج اذا رغبوا الحجز بالعملة الصعبة أو الأشقاء العرب فيكون ٤٠٠٠ دولار .

وبالنسبة للاسكان فوق المتوسط فهو ٣٠٠٠ جنيها مصريا وللمواطنين المصريين بالخارج اذا رغبوا الحجز بالعملة الصعبة والأشقاء العرب ٨٠٠٠ دولار وبالنسبة للاسكان الفاخر فهو ٥٠٠٠ جنيها مصريا وللمصريين بالخارج اذا رغبوا الحجز بالعملة الصعبة والأشقاء العرب ١٥ ألف دولار .

وقد ترك لكل شخص تحديد المنطقة التى يرغب الحجز فيها حسب أولويات الرغبات بعد سداد مقدم الحجز قبل نهاية مارس ١٩٧٥ علاوة على أن توزيع هذه الوحدات سيتم عن طريق الحاسب الألكترونى .

وعن طريقة الدفع والأماكن التى يتم الدفع فيها فقد قال المهندس محمد عصام عباس المسئول عن المشروع يتم ايداع مقدمات الحجز فى بنك القاهرة والبنك الأهلى المصرى وجميع فروعها ومراسليهم بالخارج وعند سداد القيمة يتم ملء استمارة الحجز فى البنوك وفروعها حيث تستخدم بيانات الاستمارة فى تغذية الحاسب الاكترونى ليقوم بعملية التوزيع وذلك منعا لأى تدخل بشرى .

ثم قال سيادته أحب أن أشير هنا الى شيء هام فانه عند عرض الوحدات على الحاجزين وقيمة اسعارها يكون لهم الحق فى توقيع العقد الابتدائى أما اذا اعترض الحاجز على القيمة او التصميم فانه من حقه استرداد قيمة الحجز وبالعملة التى دفعها وذلك لابد ان يتم قبل توقيع العقد .

وبعد فهذا عمل عظيم من أعمال بناء السد العالى وعلامة مضيئة على طريق المقاولون العرب ((عثمان أحمد عثمان وشركاه)) تعتمد فيها على العلم والفن فى أرقى مستوياته العالمية ، واضعه فى اعتبارها أننا نبنى مصر الحضارية فى معركة العبور الثانى بعد أن عبرنا معركة الكرامة والشرف تحت قيادة الرئيس المؤمن محمد أنور السادات .

شركة الأعمال البورسعيدية

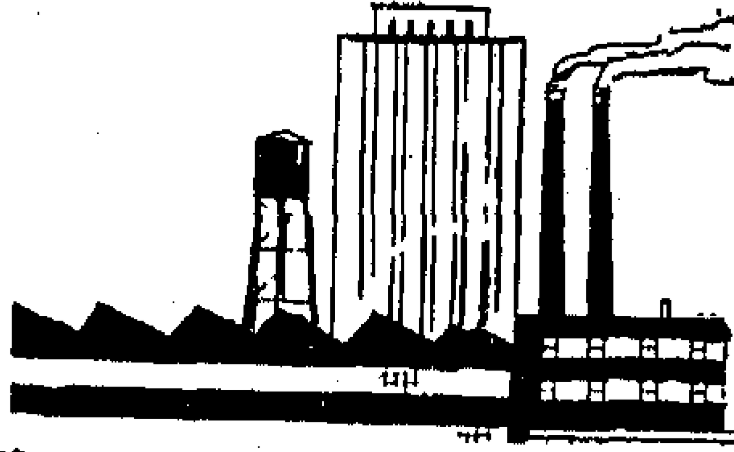
إحدى شركات هيئة قناة السويس

القاهرة : ٤ شارع محمود طلعت / مدينة نصر ت ٨٢١٩٠٤

الورش

مسطرد ت : ٨٦٧١٢٦ - بولاق ت : ٧٤٧٨٣

بورسعيد : عمارة المساجرية ماريتيم - شارع فلسطين ت : ٣٧٣٧



بورتوفيق : شارع شهداء اليمن ت : ٣٩٢٦

بور فؤاد : ت ٨٩٧٣ - القسم الالكترونى باسكندرية

٤٢ شارع سعد زغلول تليفون ٨٠٩٣٨٣

العنوان التلغرافى : " إنجنيرز "

« القاهرة - إسكندرية - بورسعيد - السويس »

إصلاح سفن • صهاريج بترول • إنشاءآت معدنية ومدنية • إصلاح أجهزة الكترونية

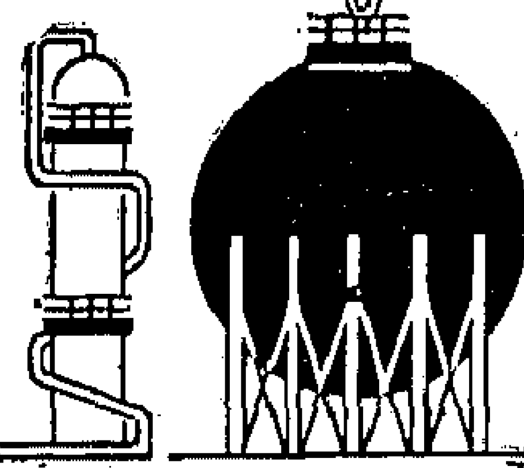
ميتالوك • إنشاء جمالونات • رادار ولاسلكى وجايرو

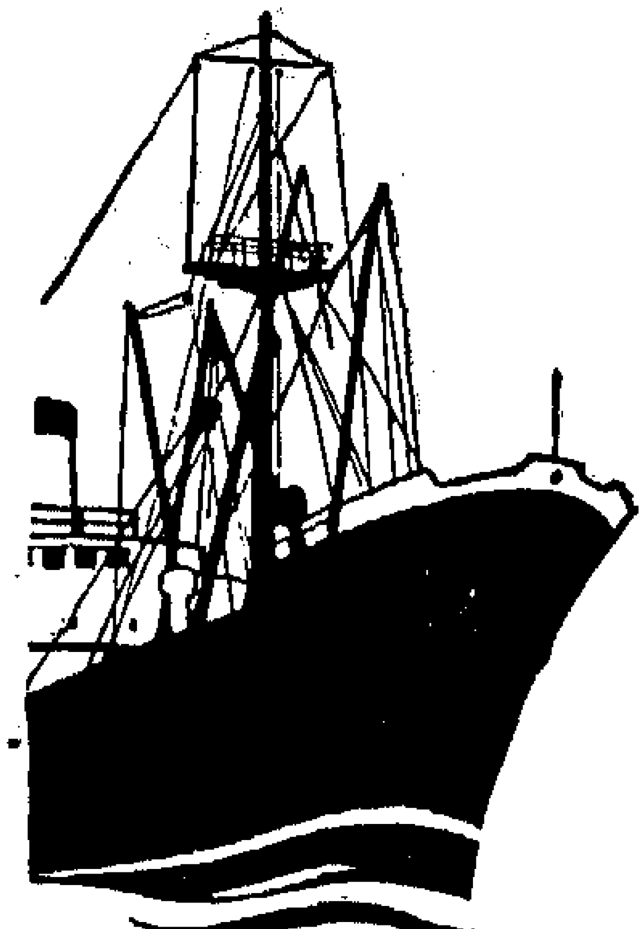
تطور نشاط الشركة

- إصلاح البواخر التى تعمل فى أعالى البحار وتمر بقناة السويس والموانى القريبة من جمهورية مصر .
- تركيب وصيانة جميع الأجهزة الألكترونية من الرادار واللاسلكى وأجهزة البوصلة البحرية بالبواخر أو بوسائل النقل الأخرى
- بناء وترميم السفن والصنادل والرفاصات والزوارق ذوات المحركات وغيرها من السفن البحرية والأعمال الخاصة بصنع الآلات وأعمال الرهان والبرشمة
- إنشاء صهاريج البترول من الأحجام المختلفة التى وصلت إلى ١٠٠٫٠٠٠ م٣ تقريبًا ، وبأحدث التصميمات ذات الأسقف العائمة التى تناسب العمل فى الحقول ومناطق التخزين .
- جميع الإنشاءآت المعدنية والتركيبات الميكانيكية بالمصانع والورش



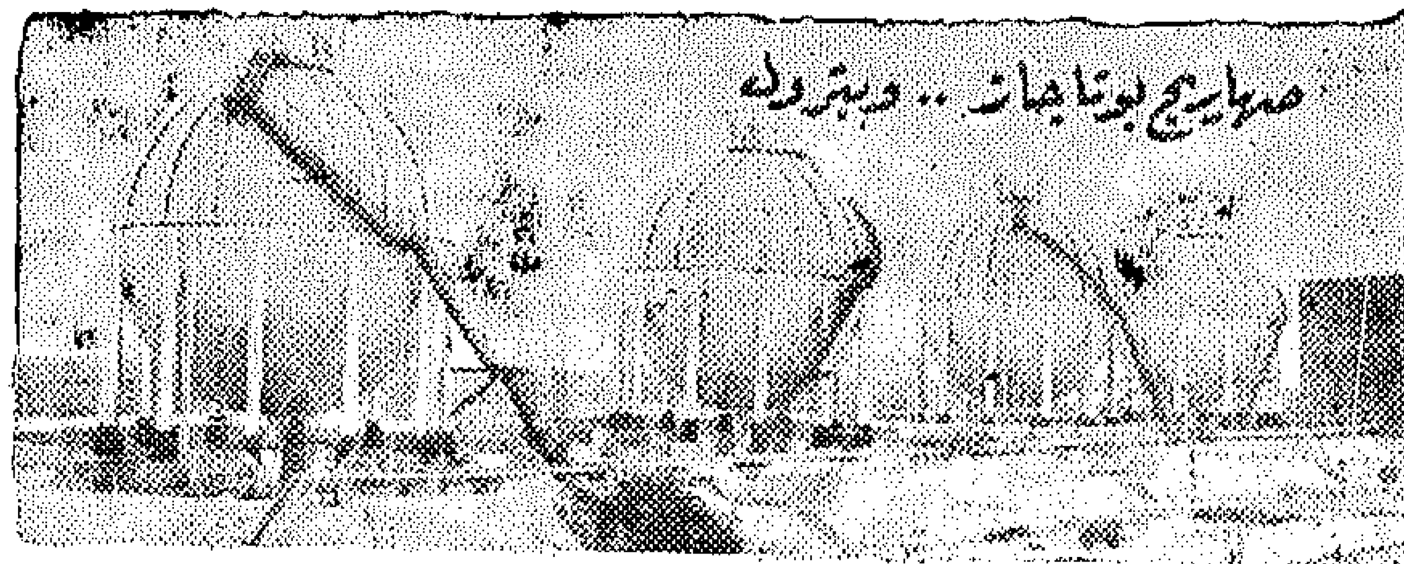
رادار ولاسلكى وأجهزة الكترونية





إصلاح السفن

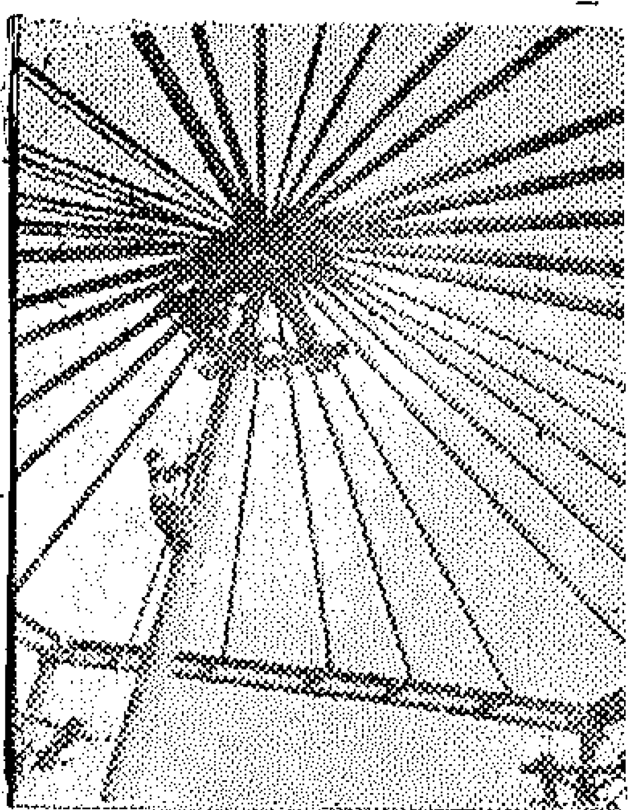




صهاريج بوتاجاز .. وبترول



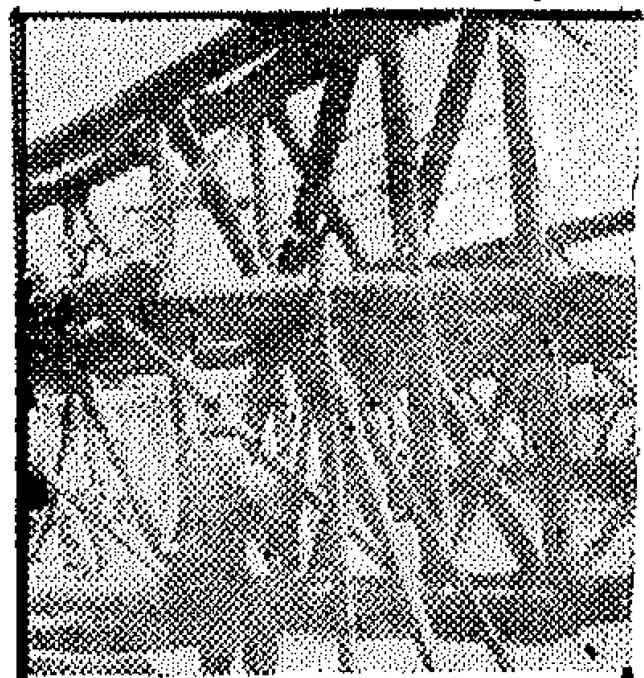
ميتالوك



إنشاء الجمالونات

بعض الأعمال الهامة التى نفذتها الشركة أخيرًا

- مجموعة مستودعات التخزين برأس شقير بالبحر الأحمر لشركة جابكو (بترول خليج السويس) تتكون من عدد ٨ صهاريج سعة ٢٦٨٫٠٠٠ برميل سقف عائم ٢ صهريج سعة ٥٠٠٫٠٠٠ برميل سقف عائم ، ويبلغ وزن الحديد المستعمل فى هذه العمليات حوالى « عشرة آلاف طن »
- مجموعة مستودعات بالعلمين بالصحراء الغربية لشركة ويبكو (بترول الصحراء الغربية) تتكون من : ٣ صهاريج سعة ٢٦٨٫٠٠٠ برميل سقف عائم ، ٢ صهريج سعة ٣٠٫٠٠٠ برميل سقف ثابت) ويبلغ وزن الحديد المستعمل فى هذه العملية ٢٥٠٠ طن « ألفان وخمسمائة طن »
- جميع مستودعات البترول لشركة النصر للبترول بمعملها الجديد بإسكندرية وتتراوح ما بين ١٥٠٫٠٠٠ برميل ، ١٠٠٫٠٠٠ برميل وعددها ١٥ مستودعا
- ٤ صهاريج كروية لتخزين غاز البوتاجاز بالإسكندرية سعة ١٠٠٠ م٣
- معظم الصهاريج الجاهزة الصنع الواردة من روسيا والمركبة بجمهورية مصر
- الإنشاءآت المعدنية الخاصة بآبار البترول داخل البحر، وهى الأرصفة العائمة وحواملها • مهابط الطائرات
- الكبارى الحاملة للشعلة وقد نفذت الشركة الكثير منها ولأول مرة بجمهورية مصر العربية بعد أن كان يستورد من الخارج وتم تنفيذها فى زمن قياسى وبكفاءة وإتقان عالميين ، وتحت التفتيش الدولى لمثل هذه المنشآت الخاصة



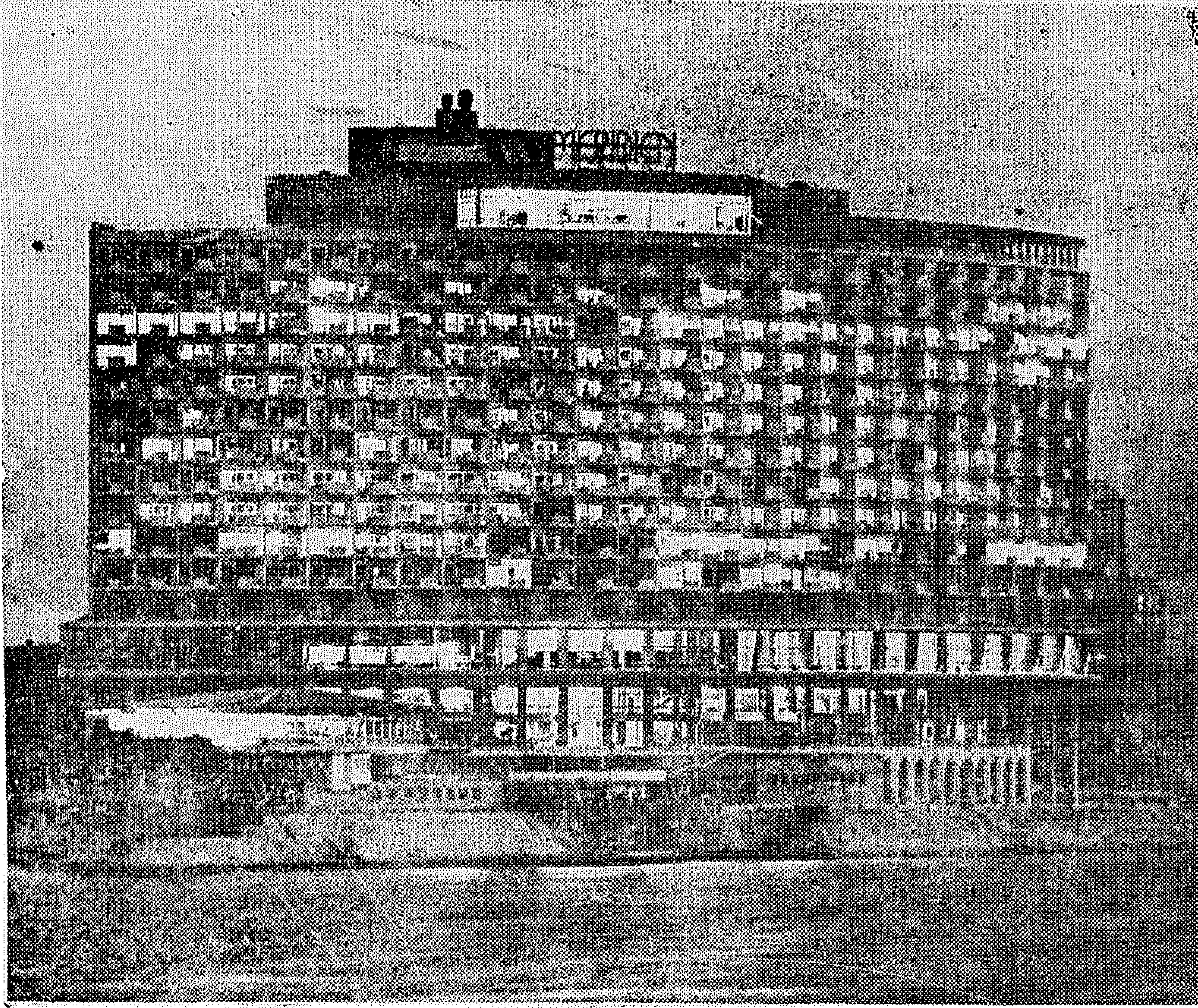
إنشاءآت معدنية ومدنية وأعمال خاصة

الوكلاء والجهات التى تمثلها الشركة

- شركة مذر ويل برديج بإسكتلندا
- الإتحاد الدولى للميتالوك لإصلاح كسور وشروخ أجزاء الماكينات بطريقة الميتالوك
- شركات الرادار والجيرو والأجهزة الالكترونية واللاسلكية

« ديكا - كلفن هيوز - ماكاى ماركونى - ار سى ايه - أطلس براون - أنشوتس - سبيرى رادفون - سيمنس - كاجينوك »

فندق ميريديان القاهرة



٦ أكتوبر ١٩٧٣ ٦ اكتوبر ١٩٧٤

- سنة من حياة مصر تحول فيها مجرى التاريخ
- سنة تمثل أملا بعد يأس
  وصحوة بعد ركود
  واشراقا بعد ظلام
- سنة نقدم قبل نهايتها هذا المبنى الفريد فى موقعه فى قلب القاهرة الفريد فى عمارته التى تعبر عن اصحاب أقدم وأعرق الحضارات
- هذا المبنى الذى لمسته روح العهد الجديد فاضاءت كل ركن من أركانه ودبت الحياة بين جدرانه وتهيأت له الاسباب ليؤدى دوره فى خدمة مصر . . .
- ونحن الذين بذلنا عصارة الفكر والجهد فى إنجازه رغم كل الصعاب قد صقلتنا التجربة وامتد بنا الطموح لنضع مزيداً من الفكر والجهد فى خدمة الارض الطيبة التى رواها المصريون بعرقهم ودمائهم ودموعهم
- نحن ندعو الله أن يجعل هذا العمل المعمارى الكبير فألاً حسناً نحو المستقبل المضئ الذى تهفو اليه قلوب المصريين
- نحن نهدى هذا العمل للذين حملوا الشعلة فى مطلع هذه السنة الخالدة فى تاريخنا بالقرار والتخطيط والتنفيذ وأولا وقبل كل شئ لاصحاب كل قطرة دم أريقت ليتحقق لهذا البلد العزيز ما يرنو اليه من عزة وكرامة .

شركة التعمير والمساكن الشعبية

التصنيع والانتاج

جمعية المهندسين الكهربائيين
والالكترونيين
جمعية الهندســـــــة الادارية
جمعية المهندسين الميكانيكيين

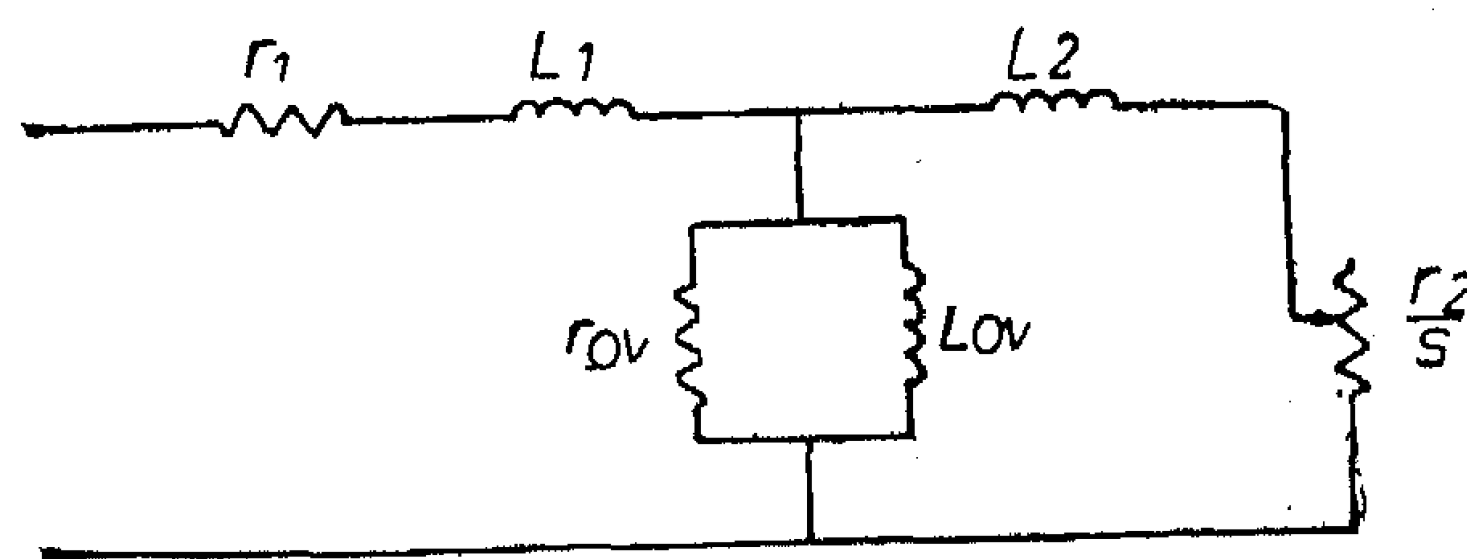


Fig. 10

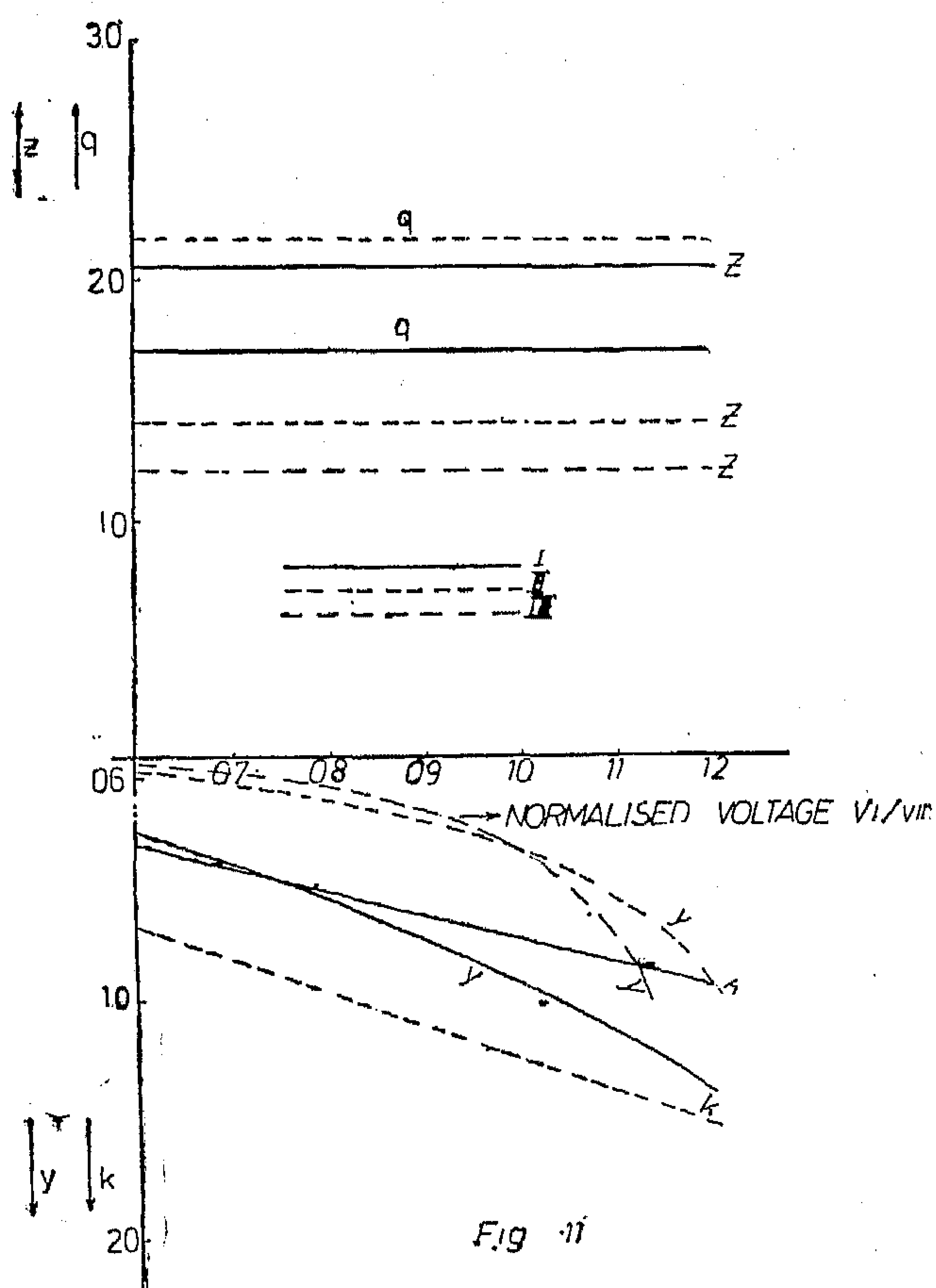


Fig 11

IV. CONCLUSIONS

The variation of supply voltage or supply frequency will change the main and leakage magnetic flux, which in turns — affects mainly the rotor resistance r_2, the core loss resistance r_o and the magnetising industance L_o. There will be a slight change in the other parameters of the induction motor. However, in the considered range of variation ($0.6 < \lambda_v, \lambda_f < 1.2$), this change is not noticeable. As a result, only the three parameters r_2, r_o and L_o will depend on the supply voltage and the supply frequency, from which the first one depends only on the supply frequency due to the skin effect and the effect of the main and leakage flux variation, while the other two parameters depends on the supply frequency as well as on the supply voltage due to the effect of saturation.

Emperical formulae are obtained for the dependence of the different parameters of the induction motor equivalent circuit on the magnitude and frequency of the feeding voltage.

The developed method and obtained emperical formulae are applicable within a certain range of variation i.e.
$0.6 \angle \lambda_v, \lambda_f \angle 1.2$.

REFERENCES

(1) J.F. LINDSAY and T.H. BARTON "Parameter identification for squirrel cage induction machines"

Transactions paper presented in the IEEE power engineering society, January 28-February 2, 1973.

(2) A.S. LANGSDORF "Theory of Alternating Current Machinery" (Text book), McGraw-Hill Book Company Inc. 1955.

where
g and h - are some constants for a specified motor fed by a nominal voltage as given in table I.

k, q, y and z — are some constant depending - for specified motor - on the supply voltage as shown in Fig. 11.

Table I

Motor No.	I	II	III	V
g	0.25	0.6	0.38	0.51
h	0.75	0.4	0.62	0.49

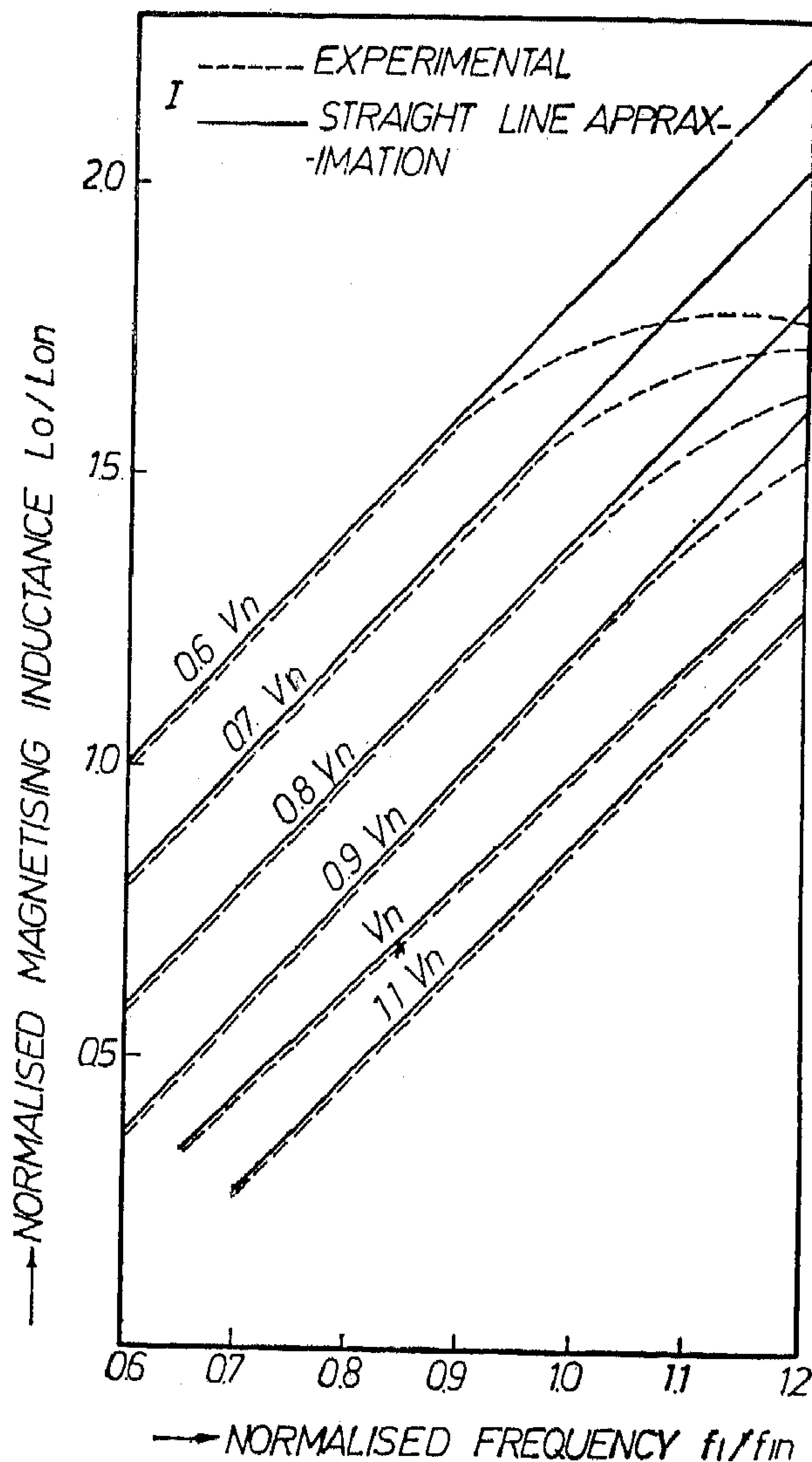


Fig 8

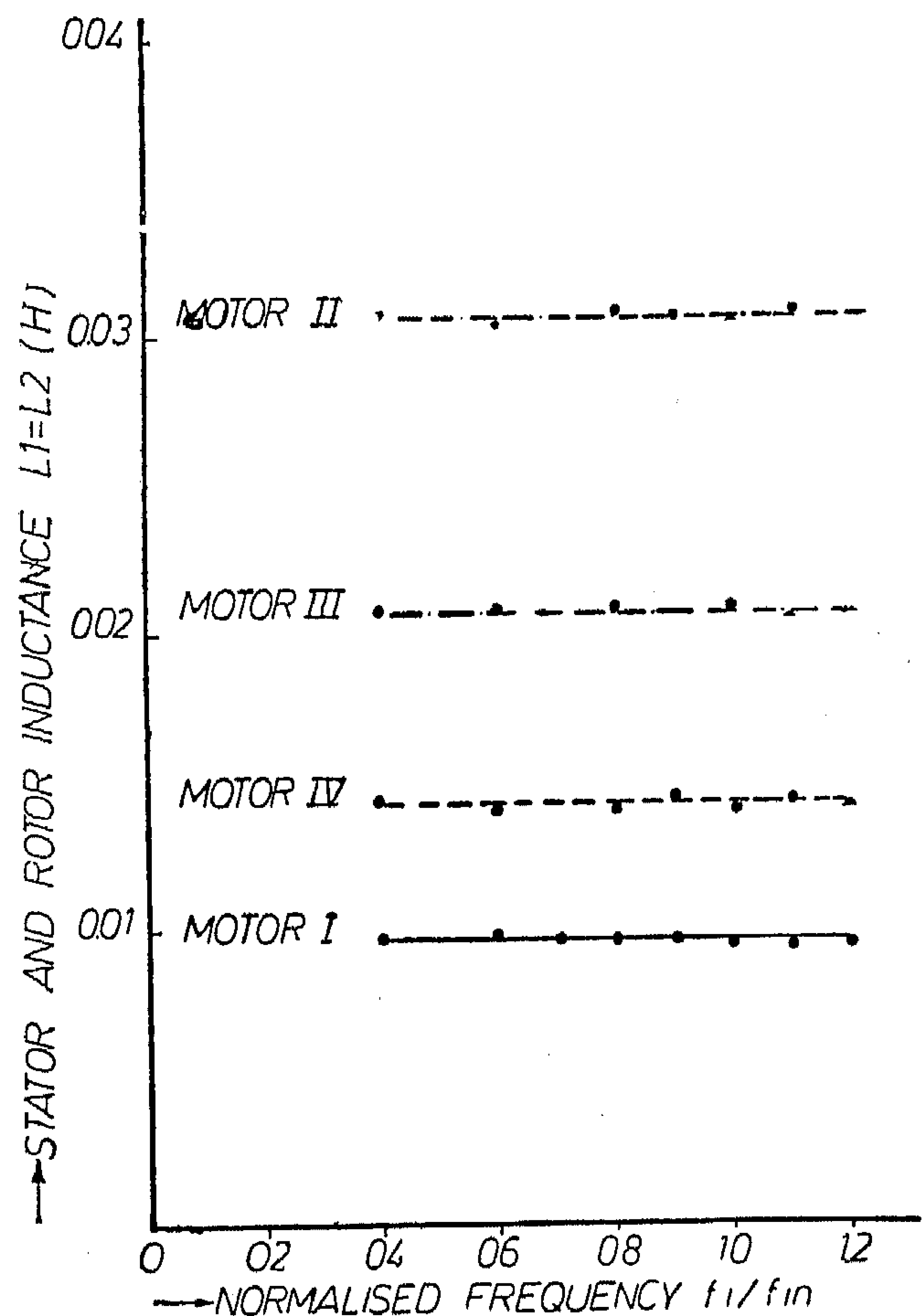


Fig 9

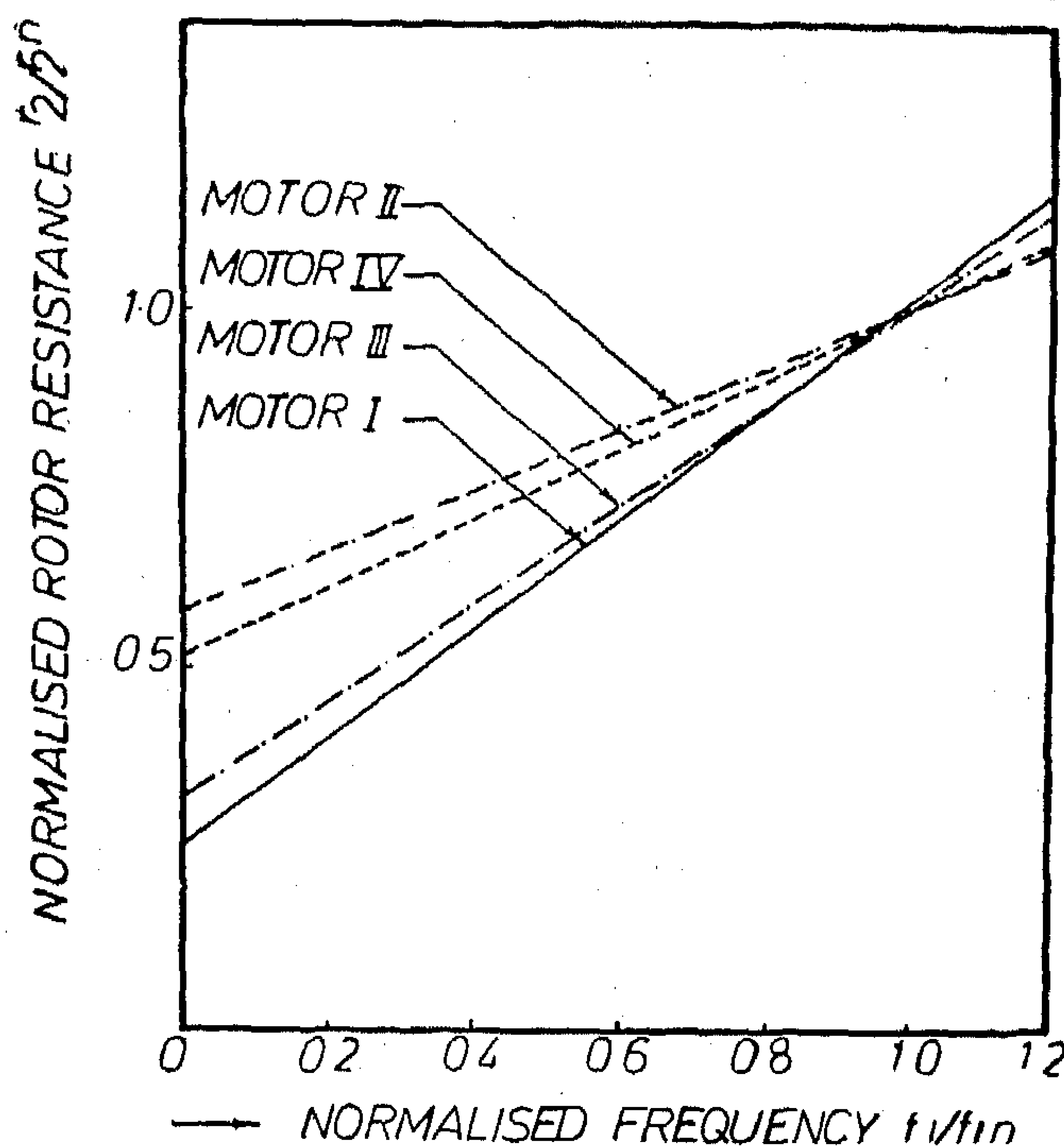


Fig 6

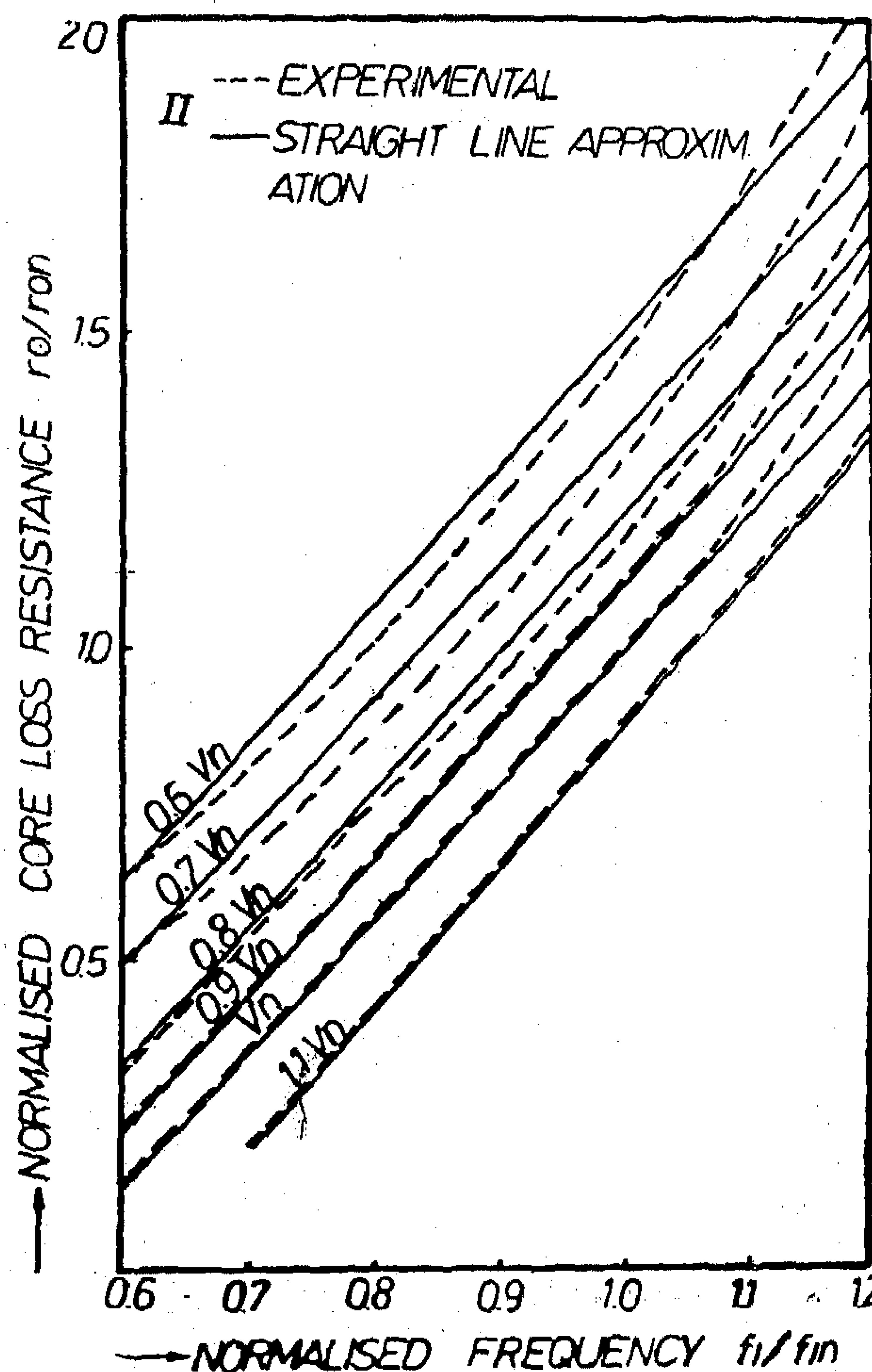


Fig 7

where :

a, b, c and d are some constant depending - for specified motor - on the supply frequency as shown in Fig. 5.

The variation of the equivalent circuit parameters of the investigated motors as a function of the supply frequency are shown in Figures (6 — 8). It is noticed that the frequency variation affects mainly the rotor resistance r_2, coreloss resistance r_o and magnetising inductance L_o. This is due to the fact that, the variation in the supply frequency - with the voltage kept constant - will produce an opposite change in the flux Φ. Hence the variation of r_o and L_o with the frequency is the inverse of their variation with the supply voltage. On the other hand, the rotor resistance will vary with the supply frequency due to the skin effect and the effect of the main and leakage flux variation. Also, there is a slight change in the stator and rotor inductances L_2 and and L_2, due to the variation of main and leakage fluxes. However, this change is not noticeable as shown in Fig. 9. Then the stator and rotor leakage inductances L_1, L_2 may be considered constants. Therefore, the equivalent circuit of the induction motor fed from variable frequency and constant voltage can be represented as shown in Fig. 10, where the subscript (f) indicates that the actual value is dependent on the supply frequency.

By plotting r_2/r_{2n}, r_o/r_{on} and L_o/L_{on} versus λf - as shown in Figures - and by analogous discussion the following emperical formulae can be written :

$$r_{2f} = (g + h\lambda_f)\, r_{2n} \tag{7}$$

$$r_{of} = (k + q\lambda_f)\, r_{on} \tag{8}$$

$$L_{of} = (y + z\lambda_f)\, L_{on} \tag{9}$$

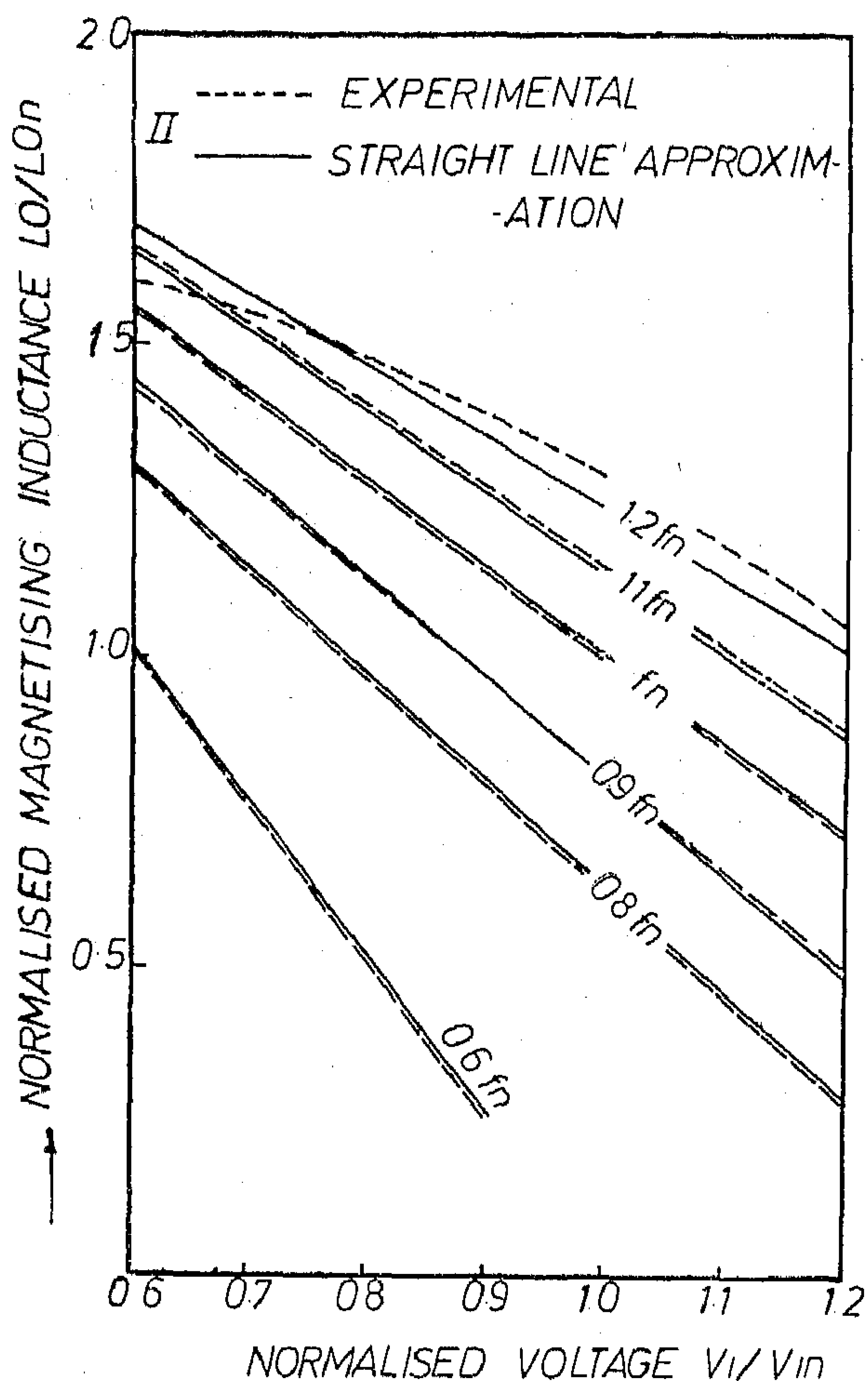
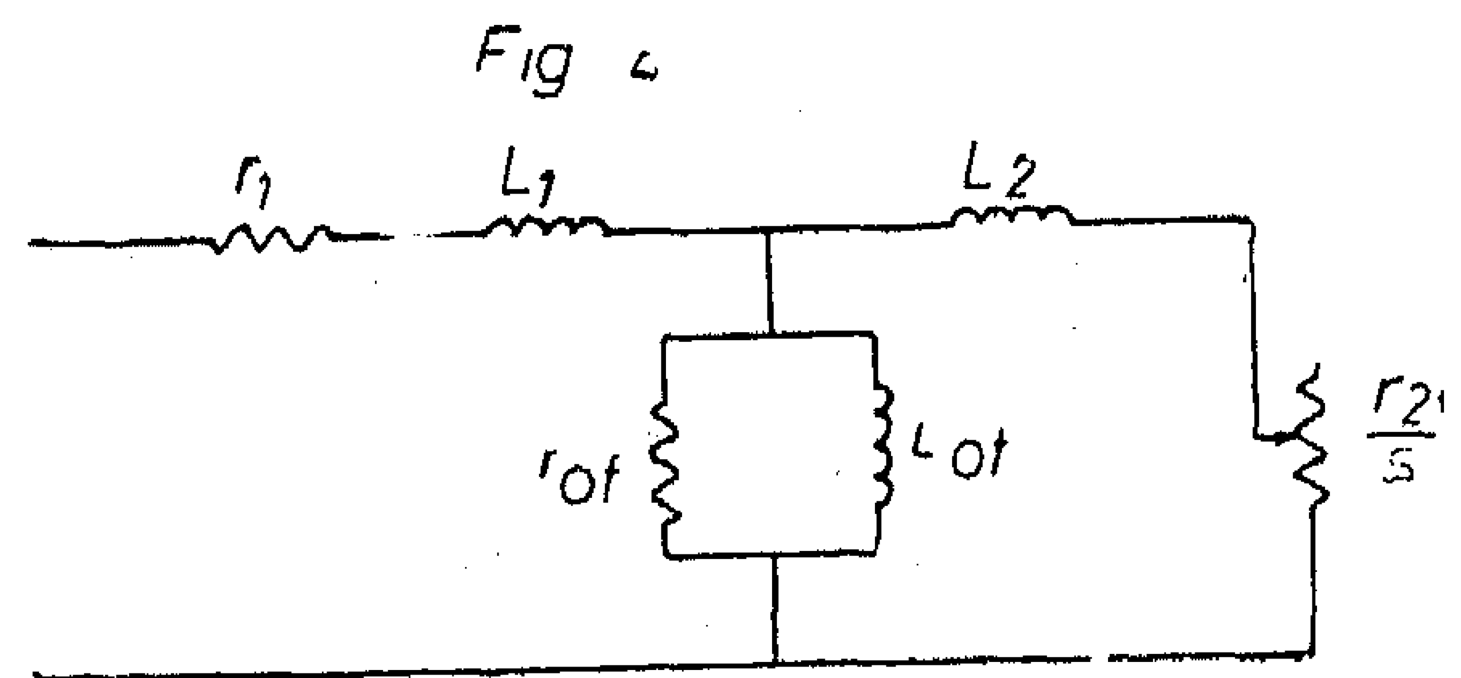


Fig 3



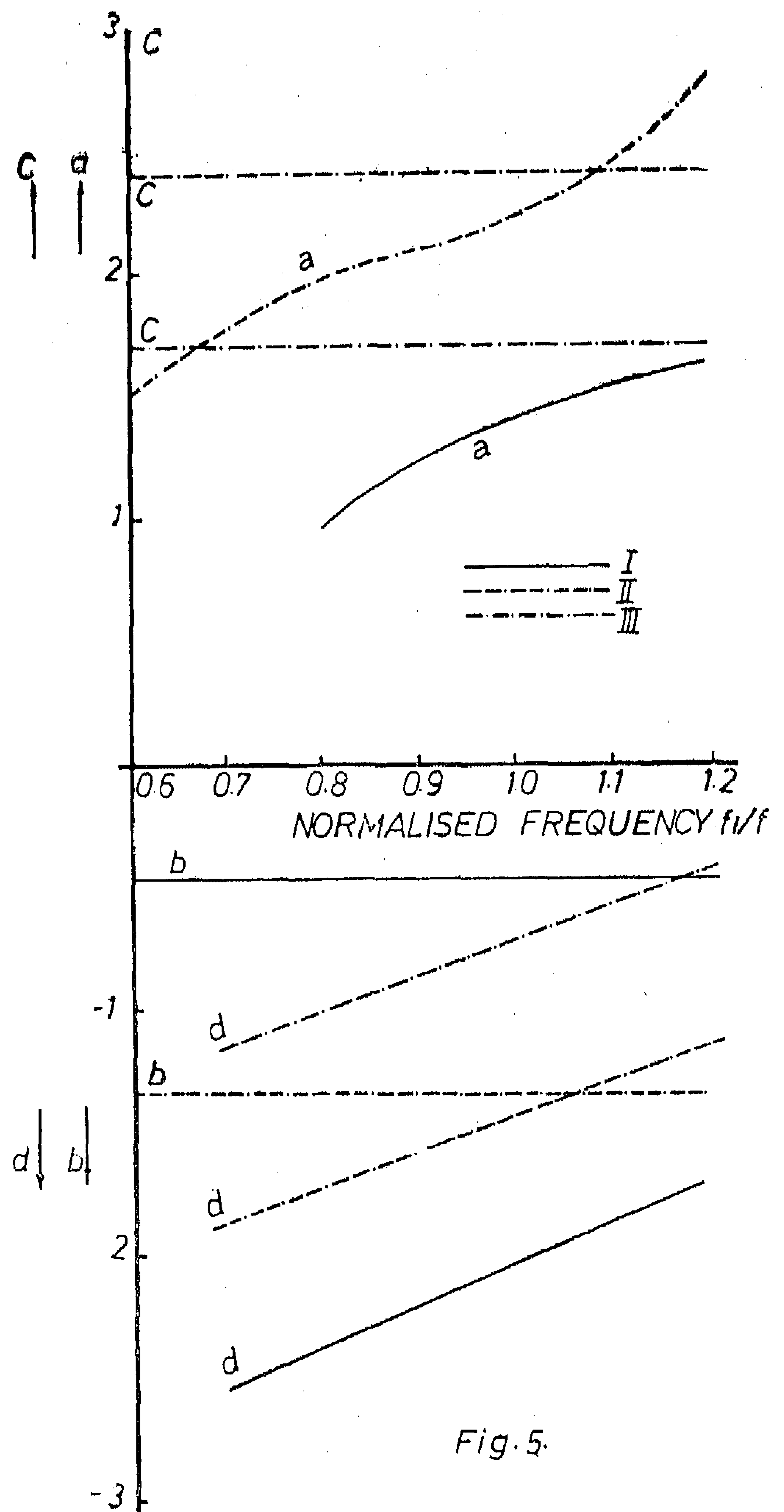


Fig. 5.

However, since the values of $V \leqq 0.6$ Vn have no practical interest, due to the large reduction in motor torque, only the range of $0.6 < \lambda_v < 1.2$ will be considered to obtain mathematical formula for these two variable parameters as a function of the supply voltage. This is done by plotting r_o / r_{on} and L_o / L_{on} against λ_v as shown in Figs. (2 and 3). From these curves it is clear that r_o and L_o may be considered - with a reasonable degree of approximation - varying linearly with this supply voltage in the range of $V > 0.6$ Vn. Then the following emperical formulae can be written :

$$r_{vo} = (a + b \lambda_v) r_{on} \quad (5);$$
$$L_{ov} = (c + d \lambda_v) L_{on} \quad (6);$$

d) The stator and rotor leakage reactances are equal, i.e. $x_1 = x_2$.

Both tests (no-lod and blocked-rotor) are carried out at different supply voltages and different supply frequencies for four different induction motor.

(4; 3; 2.2 and 1.5 Kws).

The three-phase system-supplying the investigated motors is obtained from three-phase alternator driven by an adjustable speed d. c. motor.

Using the test results and equations (1 — 4). the motor parameters at diffeent supply frequencies($0.2 \leq \lambda_f \leq 1.2$) and at dinerent supply voltages ($0.2 \leq \lambda_v \leq 1.2$ are calculated. The test results are shown in figures 2;3 and 6 — 8. The general behaviours of the variation of each parameter with the voltage and frequency is nearly the same for the different motors.

III — RESULTS AND DISCUSSION

Figures (2 and 3) show that, the varation of supply voltage - with the supply frequency constant - affects mainly the core loss resistance r_o, and the magnetising inductance L_o. Therefore, the equivalent circuit of the induction motors at variable supply voltage and constant frequency will be as shown in Fig. 4, where the subscript (v) indicates that the actual value is depending on supply voltage.

From these curves shown in Figs., it is clear that r_o and L_o increases with the supply voltage up till a certain maximum value and then decrease. The maximum values of r_o and L_o — for specified motor — depend on the operating frequency.

This is due to the fact that in the range $0.2 \leq \lambda_v \leq 0.6$, the iron parts are not saturated. Therefore, the relative increase of core losses in this range is less than relative increase in the supply voltage, and hence r_o is is increased. Also, the magnetisting current increases in lesser proportion than the increase of the voltage and hence L_o is increased. At the range $0.6 \leq \lambda_v \leq 1.2$ the iron parts start to be saturated and a further increase in the supply voltage is now not accomplished by increasing of the flux Φ, therefore r_o and L_o start to decrease sharply as the voltage increases.

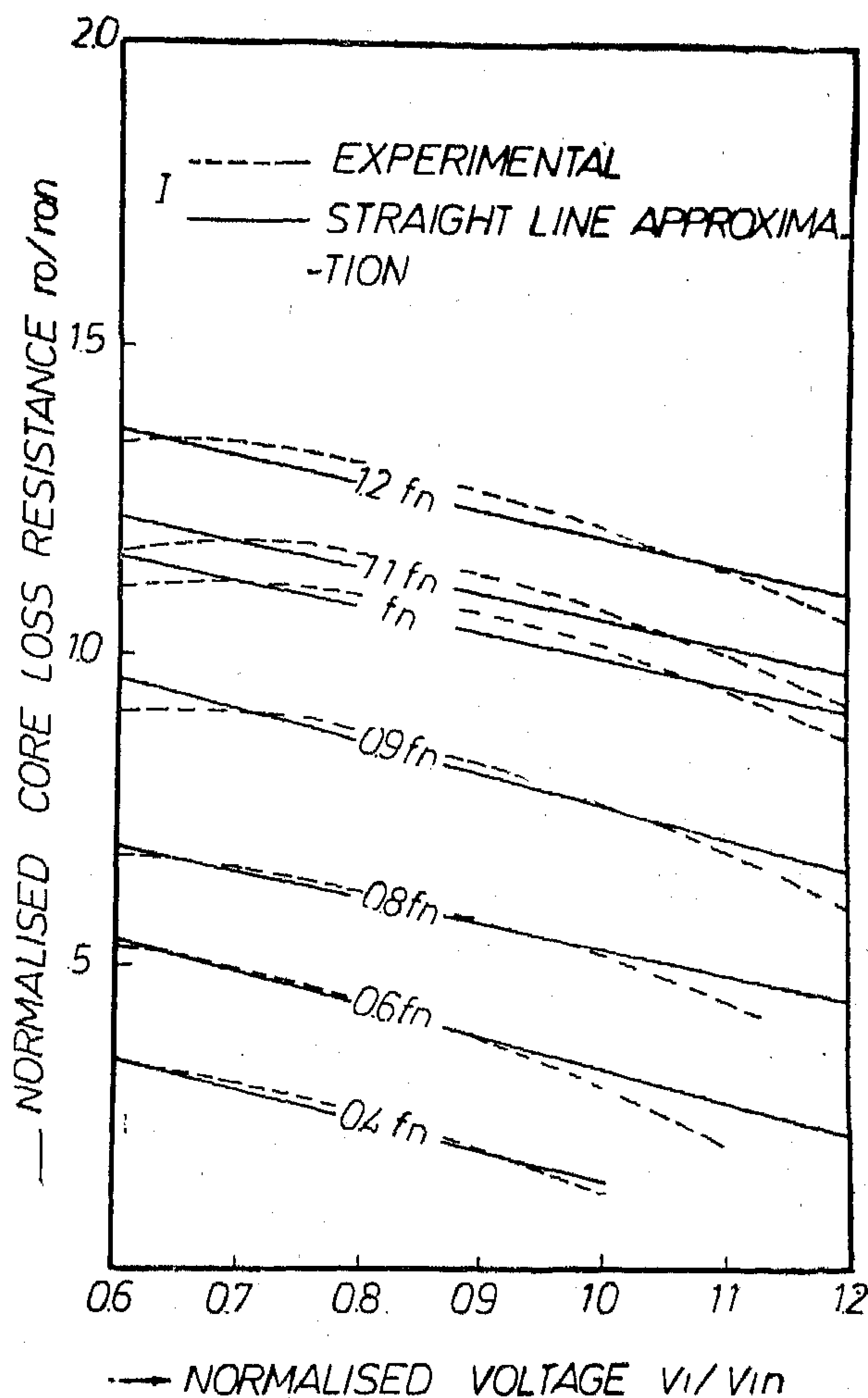


Fig 2

Subscripts

- f — Values depending on the supply frequency.
- n — Nominal values.
- v — Values depending on the Supply Voltage.

I. INTRODUCTION

The speed control of polyphase induction motors by changing the supply voltage and the supply frequency offers significant advantage over the other methods of speed control, as the frequency and hence, the speed can be changed smoothly over a wide range.

There exists a lot of publications on the speed control of squirrel cage induction motor by changing the supply frequency. To the author's knowledge, the parameters of the motor under consideration were always taken to be constant independent of the supply frequency. However, any change in the supply voltage or the supply freqency will change the motor parameters. An analytical approach to the study of the variation of the equivalent circuit parameters of a polyphase induction motor with magnitude and frequency of the feeding voltage leads to complicated mathematical relations1 which cannot be used for any further investigation.

In this paper an experimental study for the dependence of the equivalent circuit parameters of polyphase induction motor on the magnitude and frequency of the feeding voltage is carried out. Simple emperical formulae relating these parameters with the magnitude and frequency of the applied voltages are obtained. This is done by carrying out experiments on a set of polyphase induction motors of different rating. The test results are compared for different motors and the general behaviour of the variation of each equivalent circuit parameter with the magnitude and frequency of the applied voltage is studied and a general emperical formula is obtained.

II. EXPERIMENTAL WORK

The analysis of polyphase induction motor parameters under variable supply voltage or variable supply frequency will be based on the conventional equivalent circuit shown in Fig. I. All parameters except r_1 which is measured directly are computed from no-load and blocked-rotor test results as follows :—

$$r_o = \frac{E_g}{I_{oa}} \simeq \frac{V_1}{I_{oa}} \simeq \frac{m_1 V_1^2}{P_{11}} \qquad (1)$$

$$\left.\begin{aligned} x_o &\simeq \frac{V_1}{I_o} \doteq \cdot x_1 \\ L_o &= \frac{x_o}{2\pi f} \end{aligned}\right\} \qquad (2)$$

$$r_2 = \frac{P_{s.c}}{I_1^2} - r_1 \qquad (3)$$

$$\left.\begin{aligned} x_1 + x_2 &= \left[\left(\frac{V_1}{I_1}\right)^2 - (r_1 + r_2)^2\right]^{1/2} \\ L_1 = L_2 &= \frac{x_1 + x_2}{4\pi f} \end{aligned}\right\} \qquad (4)$$

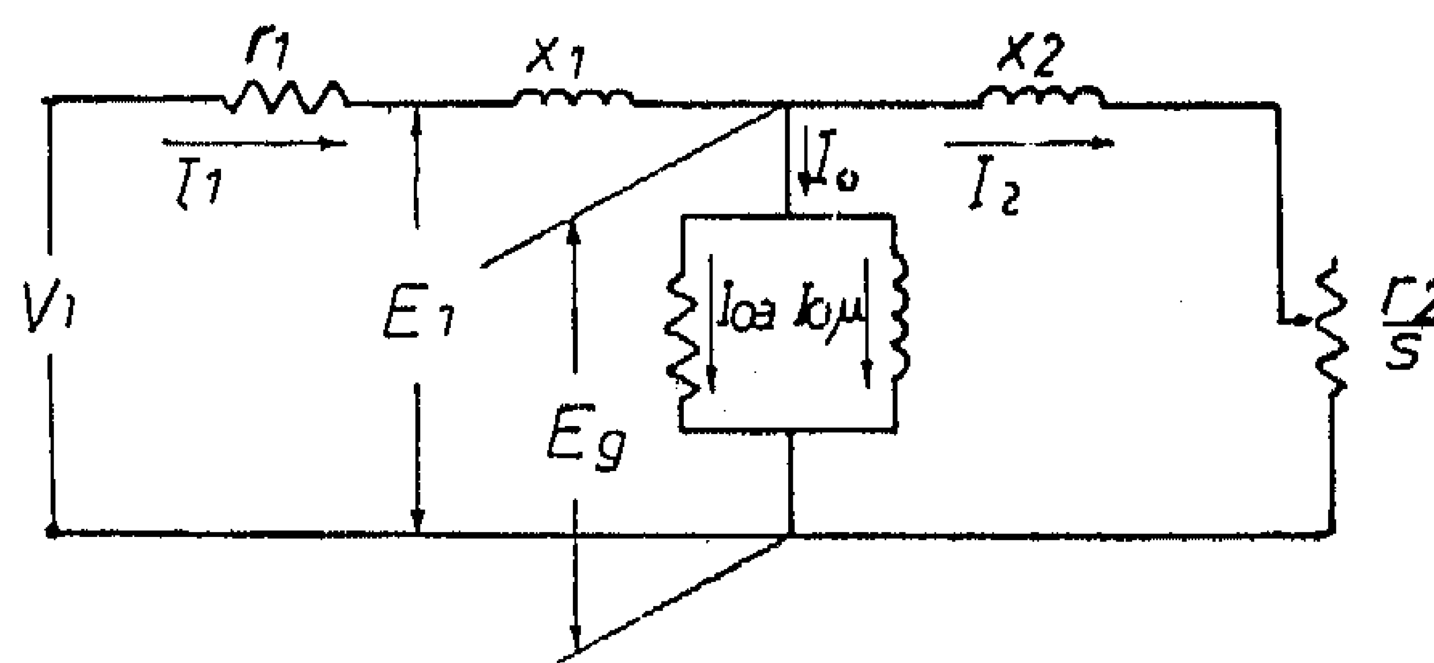


Fig. 1.

Equations (1 — 4) were derived assuming that :—

a) The magnetising impedence (r_o and x_o) is much greater than the stator impedance (r_1 and x_1), i.e. $E_g = V_1$

b) The rotor iron losses are negligble, due to the fact that the slip at no-load is nearly a vanishing quantity.

c) The magnetising current $I_{o\mu}$ is much greater than the active component of the no-load current I_{oa}, i.e. $I_{o\mu} = I_o$.

EQUIVALENT CIRCUIT PARAMETERS OF POLY PHASE INDUCTION MOTOR AND THEIR DEPENDENCE ON VOLTAGE AND FREQUENCY

By

Dr. SAYED A. HASSAN*

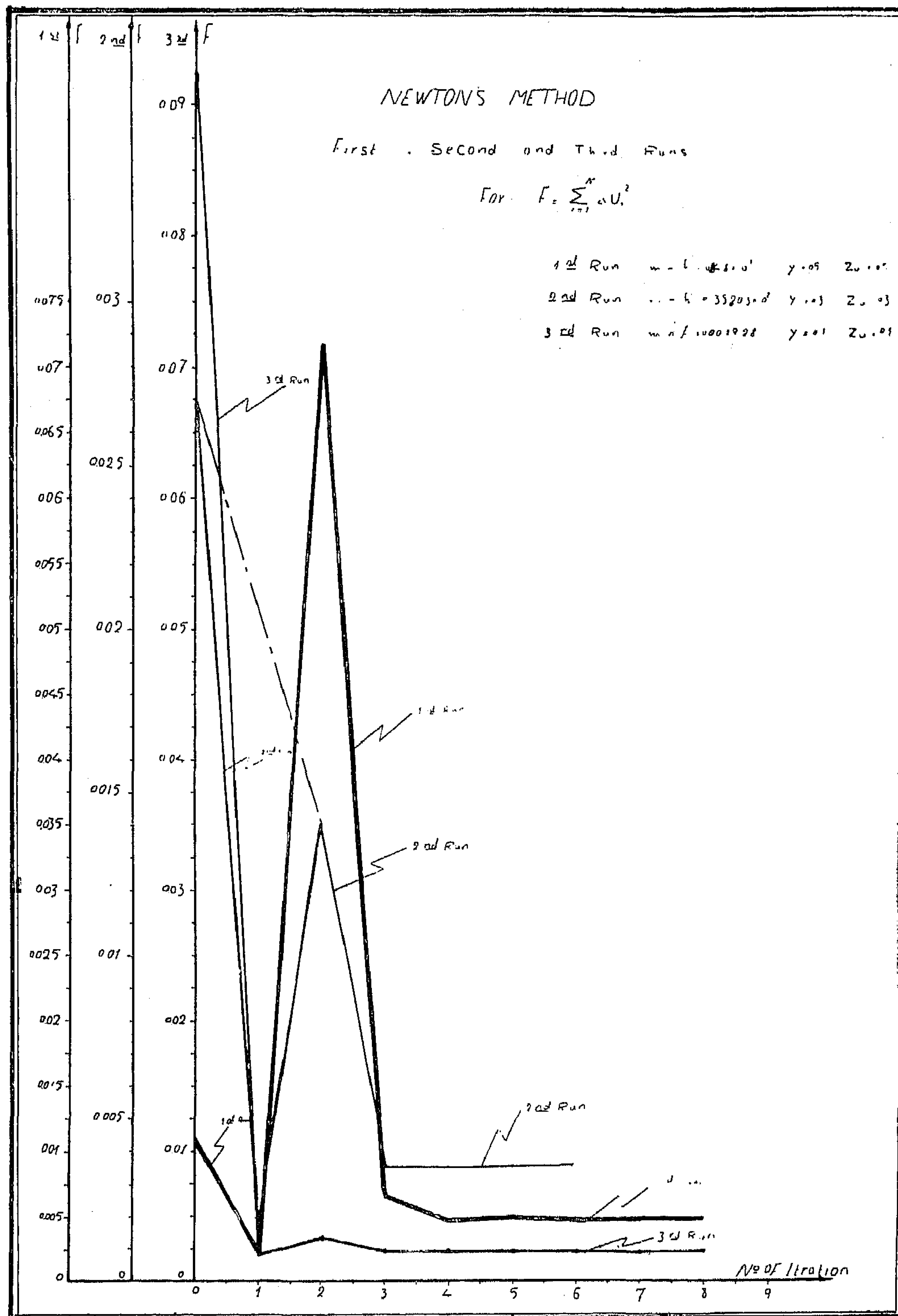
ABSTRACT

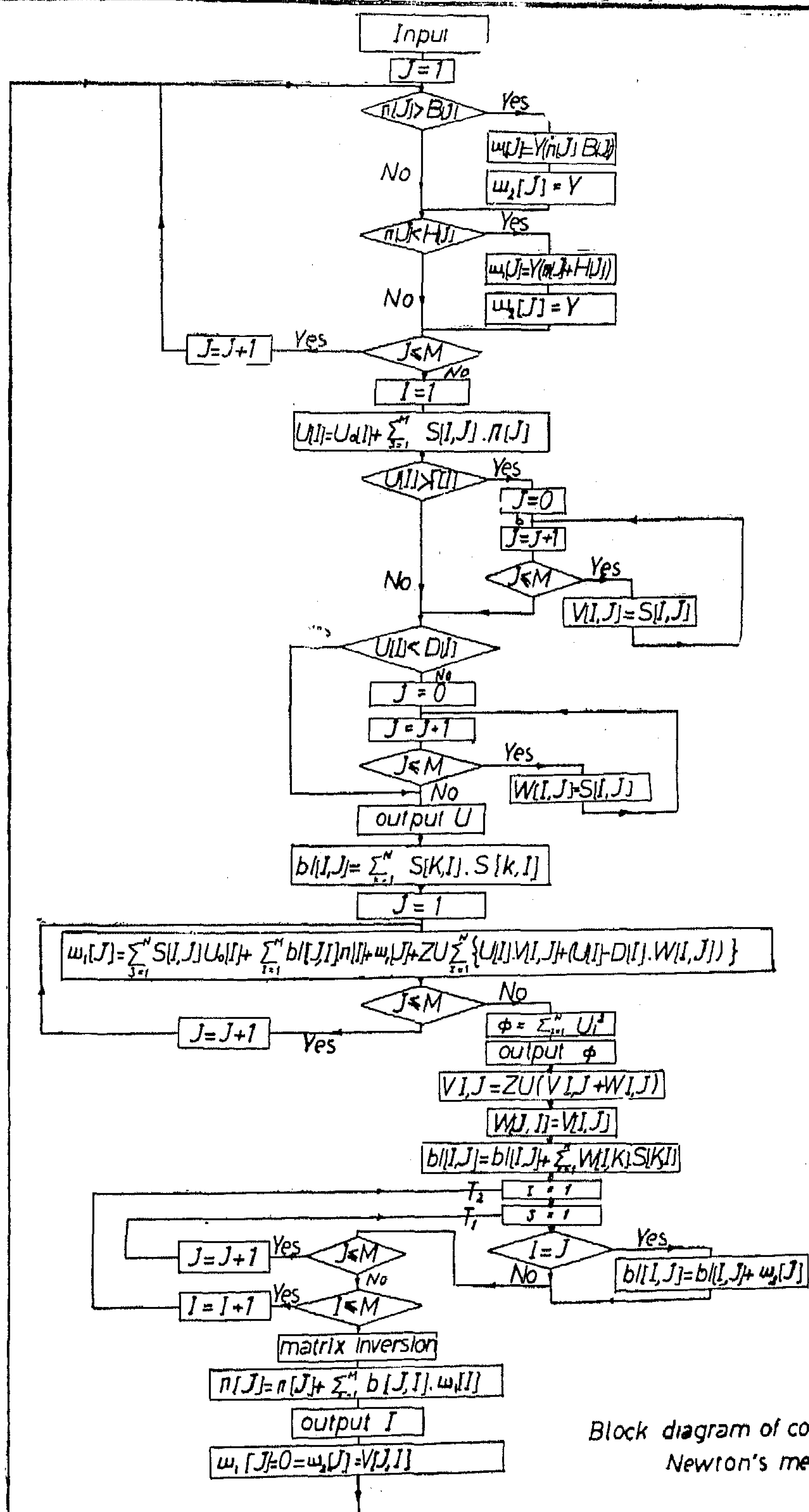
The equivalent circuit parameters of induction motors intended for service from variable voltage, variable frequency supplies, vary in wide danges with the voltage and frequency. The effect of the variation of the supply voltage, supply frequency on these parameters is studied, and emperical formulae relating the different parameters as functions of the supply voltage and the supply frequency are obtained. The obtained emperical formulae are simple and offer a solution for the parameters identification for three phase squirrel cage induction motors fed from variable frequency or variable voltage supplies.

LIST OF MAIN SYMBOLS

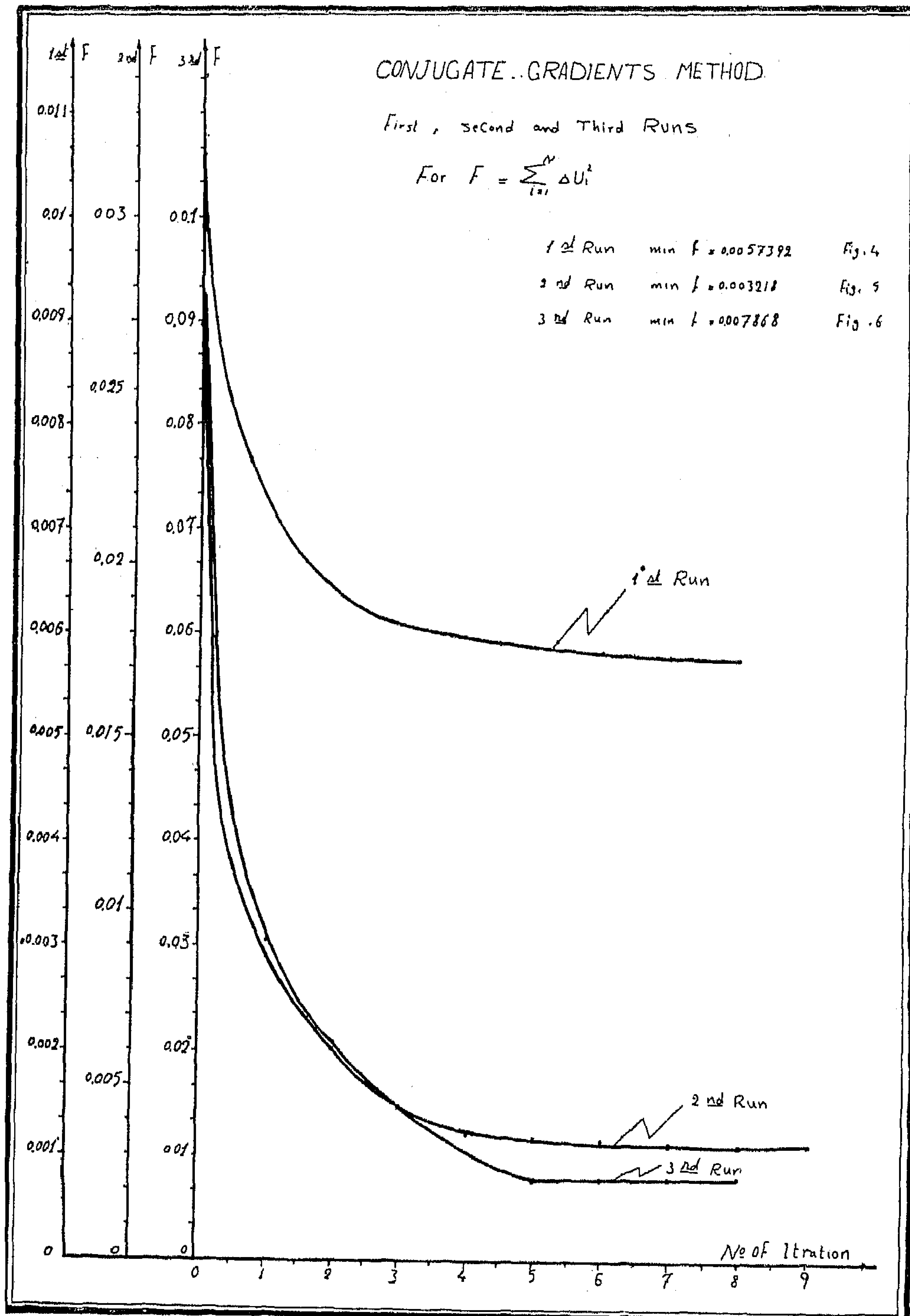
E_1	—	EMF induced by the total stator flux.
E_g	—	EMF induced by air gap flux.
f_1	—	Supply frequency.
I_1	—	Stator current.
I_2	—	Rotor current referred to the stator.
I_o	—	No-load current.
I_{oa}	—	Active component of no-load current.
$I_{o\mu}$	—	Magnetising current.
L_1	—	Stator leakage inductance
L_2	—	Rotor leakage inductance re-referred to the stator.
l_c	—	Magnetising inductance.
m_1	—	Number of stator phases.
P_{il}	—	Stator iron losses.
$P_{s.c}$	—	Power at standstill.
r_1	—	Stator resistance.
r_2	—	Rotor resistance referred to the stator.
r_o	—	Core loss resistance.
V_1	—	Applied supply voltage per phase.
Φ	—	Flux per pole.
χ_1	—	Stator leakage reactance.
χ_2	—	Rotor leakage reactance referred to the stator.
χ_o	—	Magnetising reactance.
λ_r	$= V_i/V_{in}$	Normalised voltage.
λf	$= f_i/f_{in}$	Normalised frequency.

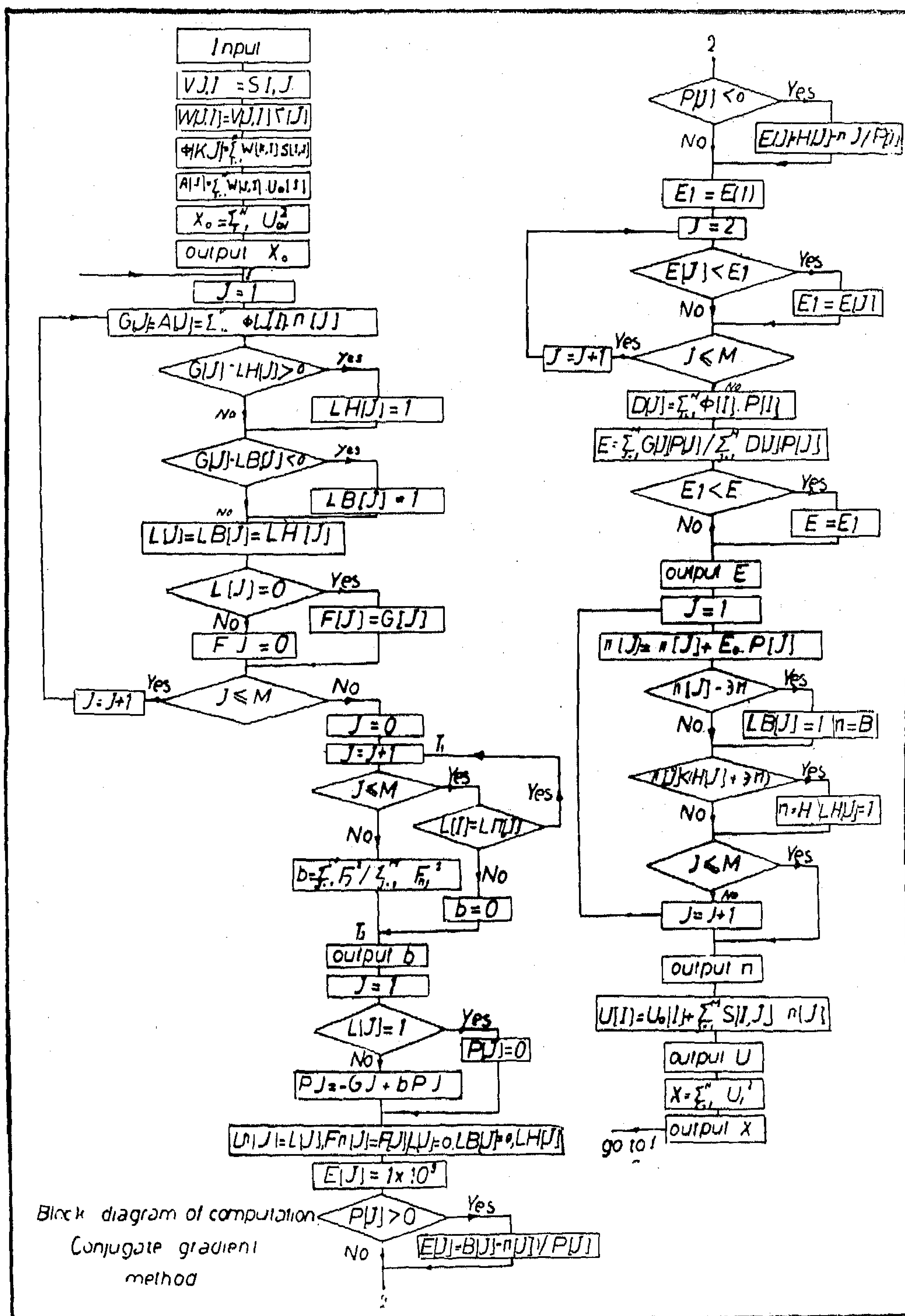
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NEWTON'S METHOD
First , Second and Third Runs
For $F = \sum_{i=1}^{N} U_i^2$
1st Run
2nd Run
3rd Run
1st F
2nd F
3rd F
No of Iteration
0 1 2 3 4 5 6 7 8 9

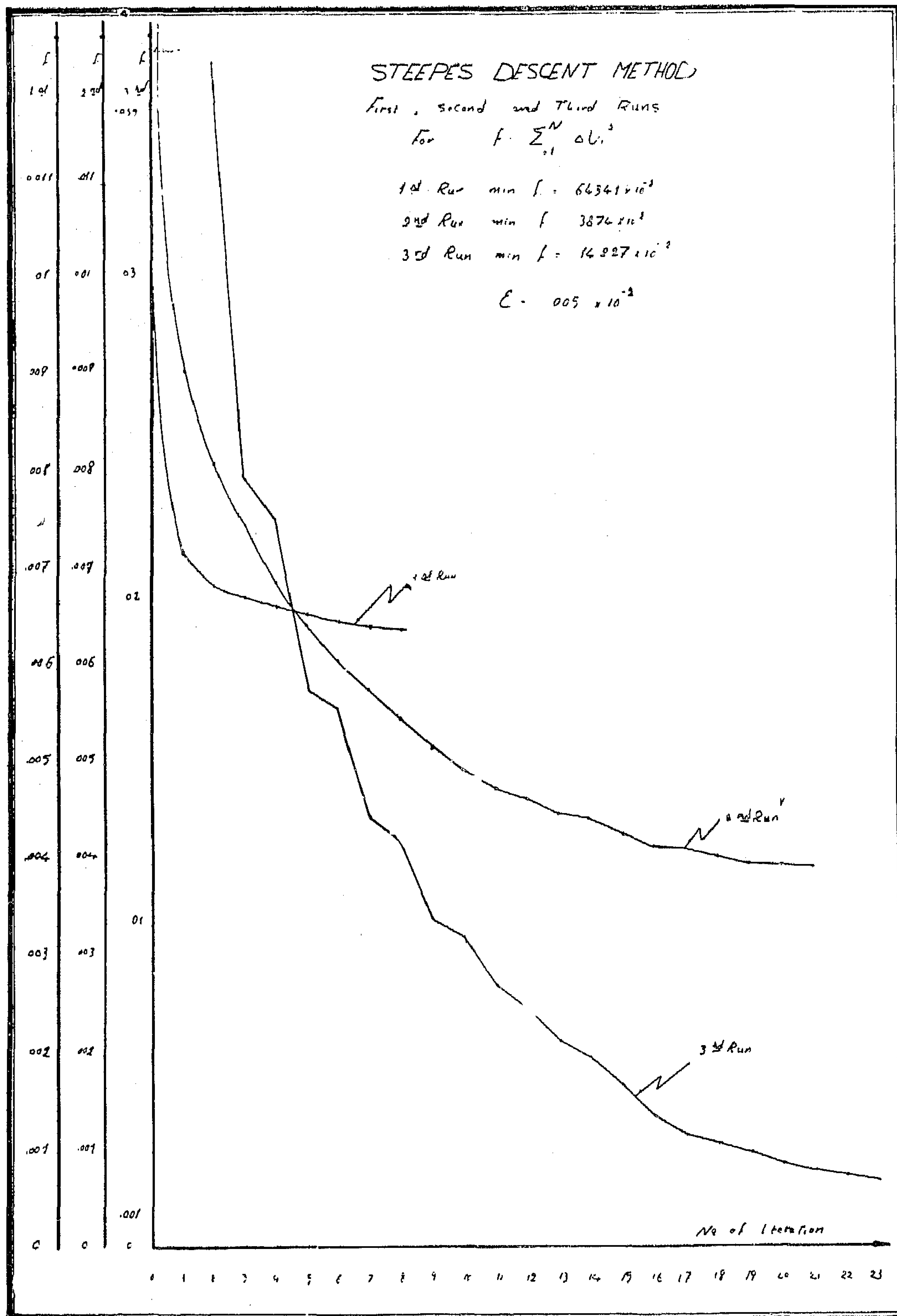


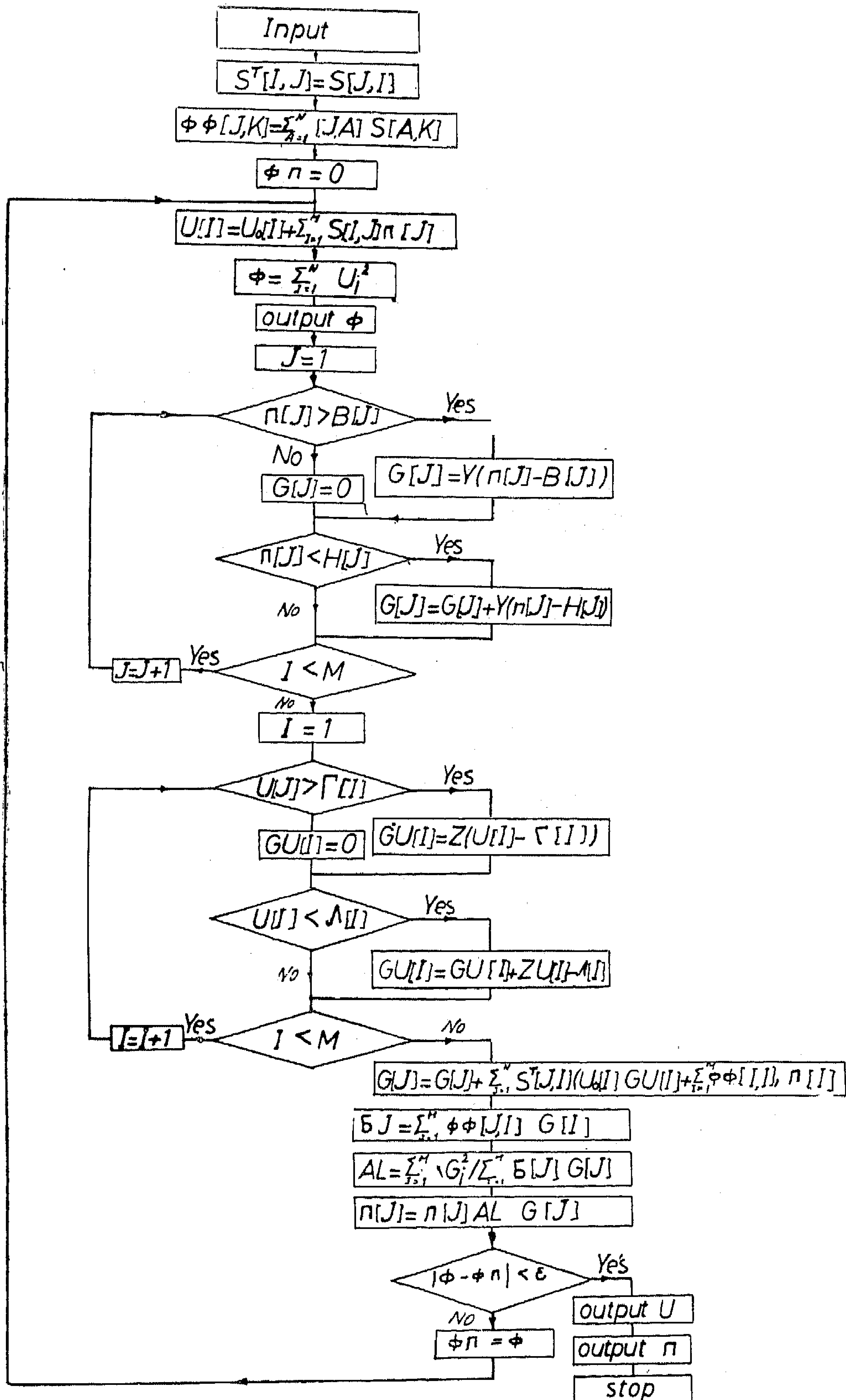
Block diagram of computation
Newton's method.


CONJUGATE..GRADIENTS METHOD
First , second and Third Runs
For $F = \sum_{i=1}^{N} \Delta U_i^2$
1st Run min F = 0.0057392 Fig. 4
2nd Run min F = 0.003218 Fig. 5
3rd Run min F = 0.007868 Fig. 6
1st Run
2nd Run
3rd Run
No of Itration
1st F
2nd F
3rd F



Block diagram of computation
Conjugate gradient
method


STEEPES DESCENT METHOD
First , Second and Third Runs
For f = Σ ΔU
1st Run min f = 64341 x 10
2nd Run min f 3874 x 10
3rd Run min f = 14.827 x 10
ε = 005 x 10
1st Run
2nd Run
3rd Run
No of Iteration



Block diagram of computation "Steepest descent" method

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Fig. 1. Schematic diagram of 12.-nodes test system.

That is or normal operating conditions (small $\triangle U$)

problem equation (12) is transformed into/

$$\min \left(A^T \Delta n + \tfrac{1}{2} \Delta n^T B \Delta n\right) \qquad (13)$$
$$\underline{\Delta n} \leqslant \Delta n \leqslant \overline{\Delta n}$$

The result of the solution of this simplified problem will be given below. Now we note that equation (13) is easier to solve than equation (12) because contraints on dependent variables are not present.

5. Pracitical example of power system voltage regulation :

A numerical example of voltage control is given for a realestic test system.

The purpose of the example is to test the algerithms of the solutions of nonlinear programming problem with constraints developed before. Consequently Newton's method, steepest descent method and conjugate gradients method were programmed for (MNP-1' Computer in Moscow USSR) and run for 3 voltages control cases with various initial voltage deviations. Recomendations are given for the best computational method.

RESULTS OF COMPUTATION

The results obtained can be formulated in short as follows.

1 — The method of conjugate gradients converges after 11 iterations when the method of steepest descent took 32 iterations and the Newton's method took 9 iterations.

2 — Time consumed per one iteration of computation for conjugate gradient method is less than the other two methods. Newton's method for M=6 took approximatly double time for each iteration.

3 — When programming the conjugate gradient algorithm it is importent to give considerable attention to the method used for determining the minimum value of the function along straight line trajectery. As a result considerable computational time may be saved.

4 — In our program for Newton's method the approximate absolute minimum appears in the first iteration. Absolute minimum gives an indication as to what extend we can minimize $\sum \triangle U^2$ without constraints.

5 — Computer core storage requiroments for Newton's method are approximately proportinal to M^3, For practical problems of high dimintionality conjugate gradient is feaslble because of less core requirements.

6 — The calculations showed that if the initial voltage deviations are big enough much more than admissible voltage deviations the conjugte gradient program gives unsuitable results.

The reason is that the program solves the following problem

$$\text{minimize} \quad \Delta U^T \Gamma \Delta U$$
$$\text{subject to} \quad \underline{\Delta n} \leqslant \Delta n \leqslant \overline{\Delta n}$$

instead of

$$\text{minimize} \quad \Delta U^T \Gamma \Delta U$$
$$\text{subject to} \quad \underline{\Delta n} \leqslant \Delta n \leqslant \overline{\Delta n}$$
$$\underline{\Delta U} \leqslant \Delta U \leqslant \overline{\Delta U}$$

But great initial deviations are very rerely found in the practice of control of normal power system operating conditions. For small initial deviations all programming methods are equally offective, conjugate gradients geing the quickest.

7 — Thus for practical problems conjugate gradient techniques formulated above is recommended.

$$\Delta U = \Delta U_o - S_U \Delta n \quad (10)$$

Where: ΔU_o initial (before control) voltage deviations,

S_U— submatrix of S with dimens ans n x M. all deviations in ΔU are counted from the desired voltages U_o

Therefore : (9) becomes:

$$\underline{\Delta U} \leq S_o \Delta n + U_o \leq \overline{\Delta U}$$

$$\underline{\Delta n} \leq \Delta n \leq \overline{\Delta n}$$

Straight forward solution of the multidimensional inequalities of equation (9) presents a serius problem.

However, from the knowledge of power system characteristies those difficulties can be avoided at least in part.

Indead; the objective of voltage control is to determine the voltage problem throughout the system which will be optimal in some respect. Let us consider optimal pattern then voltage determined when solving the problem of economic load dispatching during power system operation.

Therefor it is logical to require that the actual voltage pattern deviates from the specified as little as possible. Or instead of forecasted voltage pattern, we can consider as specified the actual pattern existing in a power system before control of regulating devices (or provious pattern called initializing, which must be admissible). —

In the simpliest case we can roughly take nominal voltages as specified voltage pattern.

In either case our task is to minimize deviations from the specified voltage pattern in nodes where voltages are observed and controlled. i.e. equation (10) can be transformed into the following mathematical programming problem.

$$\min \sum_{i=1}^{n} \Delta U_i^2$$
$$\text{subject to, } \Delta U \leq S_U \Delta n + U_o \leq \overline{\Delta U}$$
$$\underline{\Delta n} \leq \Delta n \leq \overline{\Delta n} \quad (11)$$

This transformation also corresponds to formal methods of (Ref 2) given for the solution of equation (10).

Now equation (11) can be converted in concise matrix form as follows:

$$\min \sum_{i=1}^{n} (\Delta U_i)^2 = \min (A^T \Delta n + \tfrac{1}{2} \Delta n^T B \Delta n)$$

where: $A = S_U^T \ \Delta U_o$ vector

$B = S_U^T \ S_U$ matrix

Now the problem of voltage control becomes

$$\min (A^T \Delta n + \tfrac{1}{2} \Delta n^T B \Delta n)$$
$$\text{subject to, } \underline{\Delta U} \leq S_U \Delta n + \Delta U_o \leq \overline{\Delta U} \quad (12)$$
$$\underline{\Delta n} \leq \Delta n \leq \overline{\Delta n}$$

It is a guadratic programming problem with constraints on independent (Δn) and dependent (ΔU) variables.

Further simplifications to equation (12) may be found justifiable.

Under normal operating conditions node voltage deviable little from their nominal volues. i.e. the obsolute of U is small. If the surface in multi-dimensional space formed by equation (12) is smoth enough and close to multi-dimentional parabolic surface than for small deviations in ΔU, the constraints on ΔU are not active and may be neglected.

Let us denote :

$\triangle \cap$ vector of independent variables in which the settings of regulating devices are incorporated for transformer taps and $\triangle$ Q for reactive power outputs.

$\triangle$ U vectors of dependent variables; i.e. voltage magnitude and phases of each node of power system (for a slack node total active power injection must be taken instead of phase angle).

Therefor: $\{\triangle U\} = M \times I$

$\{\triangle U\} = 2N \times I$

Where M = number of regulating devices. Detailed represention of these vectors yields:

$$\triangle n = \begin{vmatrix} Q_I \\ Q_2 \\ n_I \\ n_2 \end{vmatrix}$$

and $\triangle$ U vector of dependent variable

$$\triangle U = \begin{vmatrix} U_I \\ U_2 \\ U_n \\ \theta_I \\ P \text{ slack} \\ \theta_n \end{vmatrix}$$

Employing sensitivity relations, the dependance between $\triangle \neg$ and $\triangle$ U is given as:

$$\Delta U = S \, \Delta n \qquad (4)$$

Where : S = sensitivity matrix

Note that vectors $\triangle$ U and $\triangle \cap$ are constrained by:

$$\overline{\Delta U} \geqslant \Delta U \geqslant \underline{\Delta U} \qquad (5)$$

$$\underline{\Delta n} \geqslant \Delta n \geqslant \overline{\Delta n} \qquad (6)$$

The nature of constraints (5) lies in the fact that node voltages can not deviate from their nominal volues more than the prescribed tolerances depending an equipment rated voltages, stability conditions distribution networks operation.

Constraints (6) are equipment ratings constraints. Among 2N component of vecter U only those representing voltage magaitudes in nodes where voltages are observed and controlled will be considered limited. Therefore the voltage regulation problem can be formulated as follows :

It is required to find $\triangle \cap$ so that the following inequaties are satisfied.

$$\underline{\Delta U} \leqslant \Delta U \leqslant \overline{\Delta U} \qquad (7)$$

$$\underline{\Delta n} \leqslant \Delta n \leqslant \overline{\Delta n} \qquad (8)$$

Where :

$\triangle$ U = vector of observed and controlled voltage magnitueds. with dimension

$$\{\Delta U\} = n \times I$$

subject to

1) basic power flow equations (1 and 2) **Or**

2) linearized representation given by equation (4) of basic power flow equations.

4. **Transformation of voltage control problem :**

Now the problem is to solve equations (7 and 8) using equation (4) for $\triangle \cap$, or find $\triangle \cap$ satisfying.

$$\underline{\Delta U} \leqslant S.\Delta n \leqslant \overline{\Delta U}$$
$$\underline{\Delta n} \leqslant \Delta n \leqslant \overline{\Delta n} \qquad (9)$$

Note that : $\triangle U, \overline{\triangle U}, \triangle \cap, \overline{\triangle \cap}$ are given, S is computed and only $\triangle \cap$ are to be determined. The resulting voltage deviations

S' U can be expressed as

Morover, for steady-state operating conditions of a power system, when loads change slowly during their daily cycle, the dynamic optimization problem can be considered as a sequence of static optimization problems if the computations are fast enough.

3. Fundamental equations for reactive power distribution in terms of system nodal voltage :

The solution of power flow problems on digitial computer has become a studied practice. Among the input data which the user must specify are parameters values based on judgment (e.g. transformer tap settings). More elaborate programs adjust some of their control parameters in accordance with local criteria (e.g. maintaining a certain voltage magnitude by adjusting a transformer tap).

The power flow of the general N-node power system is described by a set of N simultaneous with camplex variables.

$$-P_i^G + P_i^L + U_i \sum_{j=1}^{N} U_j Y_{ij} \cos(\theta_i - \theta_j - \alpha_{ij}) = 0 \quad (1)$$

$$-Q_i^G + Q_i^L + U_i \sum_{j=1}^{N} U_j Y_{ij} \sin(\theta_i - \theta_j - \alpha_{ij}) = 0 \quad (2)$$

Where :

P_i^G = active power generated at node i.

P_i^L = active power consumed at node i.

Q_i^G = reactive power generated at node i.

Q_i^L = reactive power consumed at node i.

θ_i voltage phase angle at node i.

θ = O for slack node.

α_{iJ} = angle of admitiance between connected node i,j.

U_i = voltage magnitude at node i.

U_J = Voltage magnitude at node j.

Y_{iJ} = mutual admittance between node i and j.

The voltage vector U at node i is expressed in polar form :

$U_i = U_i e^{J\theta_i}$

and the admittance Y_{iJ} as $Y_{iJ} = Y_{iJ} e^{J\alpha_{iJ}}$

For simplicity, the variables and parameters involed in equations 1 and 2, namely the active and reactive power generated or consumed at every node, the voltage magnitudes and phase angles, and the conductances and the susceptances will be classfied into three vectors.

A concise way to represent this system of 2N algebraic equations is the vector equation.

$$g\ (x, U, P) = O \quad (3)$$

Where :

U = Vector of dependent variable with (2N) components.

X = vector of independent variable with (N) components.

P = vectors with denote the uncontrallable variables.

g = will denote vector function of (2N) power flow equations (1 and 2).

The solution of independent and dependent variables is in general arbitary; however, knowledge of power system characteriaties facilitates their choice.

Now, the formulation of voltage control problam is readily available and sensitivity relations in power system can be utilized.

OPTIMAL DISTRIBUTION OF REACTIVE POWER AND VOLTAGE REGULATION IN ELECTRICAL POWER

Systems (110 — 220 — 500) KV

By

Dr. ABD EL FATTAH MOAWAD

ABSTRACT :

The Primary objective of this work is to introduce an efficient new computational approach to voltage regulation and optimal distribution of reactive power in high voltage electrical networks that are capable of handling large scale systems with the security related to constraints imposed on node voltage. The approach may find many applications in power sys tem operation and planning.

INTRODUCTION :

One of the problems which frequently arises is voltage control in connected areas of power systems. It is desired that the transmission system has the ability to support voltage levels within desirable limits at load buses during normal operation and during emergencies. In the actual operation of a power system, a variety of constraints in operation exist, such as the upper and lower bounds of node voltage at power plants substations and load points.

Other constraints should be also taken into account such as the amount of reactive power available at substations and the upper and lower bounds of reactive power output capabilities of generators and syschronous condensers, i.e., the limits of over and under excitation etc.

VOLTAGE AND REACTIVE POWER CONTROL OBJECTIVES :

Voltage and reactive power flows control presents a special case of the optimum dispatching problem with limited adjustable variables.

The objective is either to minimize a departure from a prescribed voltage schedule or to minimize transmission losses while keeping voltage within prescribed limits.

The voltage at main buses (especially at load nodes) should be kept within a prescribed tolerance by a proper operation of voltage and reactive power regulation devices to cancel the voltage disturbance caused by load changes and so on.

Reactive power sources together with tap changing transfromers are utilized in a coordinated foshion to achieve the above objectives.

As a result of the optimization, and operating variable vector is determined which establishes the current settings for regulating devices such as tap-changing tranfsormers, swithched static condensers and shunt reactors, and excitating controls of generators and rotary synchronous condensers. This must be done within the equipmental limitations as installed and this involves both ratings and locations.

There equiipmental limitations may be set as a result of static optimization of a system under a desired set of operating conditions.

The static optimization is in general assumed to be a special case of the dynamic optimization.

However, it is more than that because static aptimization may actually define the confines or constraints under which the dynamic optimization is carried out.

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$R_{11} = \frac{E_1}{I_1}$, open-circuit transfer resistance $R_{21} = \frac{E_2}{I_1}$
so that $E_2 = E_1 \frac{R_{21}}{R_{11}}$

The poles of E_2 are thus the zeros of R_{11} and the poles of R_{21}.

After 4.1. and 4.2. we conclude that the poles of E_2 are simple, real negative or $\searrow$ 1.

Since our 3-terminal network (Fig. 1) may be considered as a 4-terminal network with one input and one output terminal joined together, the above property of the poles of E_2 also applies to the 3-terminal networks.

This establishes property (ii).

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It follows that the zeros of R_{11} are simple (since at a zero of higher multiplicity the function must have zero slope).

By the duality priciple ([7], pp. 246-250) it follows that for the conductance function $G_{11} = \frac{1}{R_{11}}$ the zeros are also simple, and thus the poles of R_{11} are also simple.

The results of this part can thus be summarised in the property : the zeros and poles of the driving-point resistance R_{11} are simple, real negative or $\searrow$ 1.

4.2. THE TRANSFER RESISTANCE :

The aim of the following treatment is to show that the poles of the transfer resistance R_{21} (defined in 4.3.) are contained in the pol es of the driving-point resistance R_{11} .

If to any two nodes of the network of Fig. 3 two terminals 2-2_ are fastened we get a 4-terminal network as shown in Fig. 4.

Fig. 4

4 — Terminal potentiometer network

Consider this network upon a loop basis, where the voltages E_1 and E_2 are assumed as forming the closing loops to those meshes of the network which would be left open at the terminals 1-1' and 2-2' respectively. Designating these meshes as loops 1 and 2 and applying Kirchhoff's voltage law, we get the following system of equations (Cf. [6], p. 3 and [7], pp. 134-136) :

$$
\begin{aligned}
r_{11} I_1 + r_{12} I_2 + r \quad\quad + r_{1p} I_p &= E_1 \\
r_{21} I_2 + r_{22} I_2 + \cdots + r_{2p} I_p &= E_2 \\
r_{31} I_1 + r_{32} I_2 + \cdots + r_{3p} I_p &= 0 \\
\cdots \quad \cdots \quad \cdots \quad \cdots \\
r_{p1} I_1 + r_{p2} I_2 + \cdots + r_{pp} I_p &= 0 .
\end{aligned}
\qquad
\begin{aligned}
I_1 &= \frac{\Delta_{11}}{D} E_1 + \frac{\Delta_{12}}{D} E_2 \\
\& \; I_2 &= \frac{\Delta_{21}}{D} E_1 + \frac{\Delta_{22}}{D} E_2
\end{aligned}
$$

Solving for E_1 and E_2 we get.

$$E_1 = R_{11} I_1 + R_{12} I_2$$

$$\& \; E_2 = R_{21} I_1 + R_{22} I_2$$

Therefore

$$R_{11} = \frac{\Delta_{22} D}{\Delta_{11}\Delta_{22} - \Delta_{12}^2} \quad \text{and} \quad R_{21} = \frac{\Delta_{12} \cdot D}{\Delta_{11}\Delta_{22} - \Delta_{12}^2}$$

from which we see that a pole containedin R_{21} is also contained in R_{11} .

Since from 4.1 the poles of R_{11} are simple, real negative or $\searrow$ 1, it follows that the poles of R_{21} are also simple, real negative or $\searrow$ 1.

4.3. CONCLUSION :

If we regard the end 2-2' as open, then I_2 = O, and we have

Equating expression (5) to zero, we have $x = C+A / C-B$ (7)

Which is not an explicit relation of x since A,B and and C are implicity functions in x, but the positive definiteness of A,B and C nevertheless shows that all zeros of F implied by (7) must be real negative or > 1. *

Since from (3) $R_{11} = (F)\ I_1 = 1$

It follows that the zeros of R_{11} are also real negative or > 1.

$$\text{Again } F = \frac{E_1^2}{R_{11}} \quad \text{so that } \frac{1}{R_{11}} = F(E_1 = 1)$$

This establishes that the poles of R_{11} are also real negative or > 1.

To show that the zeros and poles of R_{11} are moreover simple, consider the voltage equilibrium equations of the system (see, for example, [7], p. 227).

$$\left.\begin{array}{l} r_{11} I_1 + r_{12} I_2 + \dots + r_{1p} I_p = E_1 \\ r_{21} I_1 + r_{22} I_2 + \dots + r_{2p} I_p = 0 \\ \dots \\ r_{p1} I_1 + r_{p2} I_2 + \dots + r_{pp} I_p = 0 \end{array}\right\} \therefore I_j = \frac{E_1 \Delta_{1j}}{D}$$

Differentiating w.r.t x we get

$$\left.\begin{array}{l} r_{11} I_1' + r_{12} I_2' + \dots + r_{1p} I_p' = -S_1 \\ r_{21} I_1' + r_{22} I_2' + \dots + r_{2p} I_p' = -S_2 \\ \dots \\ r_{p1} I_1' + r_{p2} I_2' + \dots + r_{pp} I_p' = -S_p \end{array}\right\} \therefore I_1' = -\frac{1}{D} \sum S_j \Delta_{j1}$$

where $S_j = r_{j1}' I_1 + r_{j2}' I_2 + \dots + r_{jp}' I_p$

As $\Delta_{j1} = \Delta_{1j}$, then

$$I_1' = -\frac{1}{E_1} \sum_{j=1}^{p} S_j I_j = -\frac{E_1}{R_{11}^2} \frac{dR_{11}}{dx}$$

$$\therefore \left(\frac{E_1}{R_{11}}\right)^2 \frac{dR_{11}}{dx} = \sum_{j=1}^{p} S_j I_j = \sum_{i,j=1}^{p} r_{ij}' I_i I_j = B - C$$

Since the zeros of R_{11} are implied by (7), we see that for the internal zeros* of R_{11} (where $C-B \neq 0$) $\frac{dR_{11}}{d\chi} \neq 0$. *

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* This can be seen from their physical meaning since they represent energy (Cf. [5], p. 128). Mahtematically this can be proved by showing that the corresponding determinants and their principale minors are positive. For a criterion for positive defeniteness see Guillemin [9], p. 150.

* This is analogous to the treatment of LC, RL, and RC networks by Guillemin 8 p. 51, 58 and 64.

* Without considering the zeros at infinity.

* For negative zeros ($C-B < 0$), $\frac{dR_{11}}{d\chi}$ is positive; whereas for zeros > 1, the slope of the function R_{11} is negative.

Here H (y) is a polynomial in y.

On account of (2) it can be proved that the coefficients of H (y) are all real positive (Cf. [10], pp. 116, 124).

It follows that the zeros of $\triangle_{12}$, and honce of E_2, are either real non-positive y's or occur in conjugate complex pairs*.

Refering to our variable $= \chi \frac{1}{1+y}$ we find that the zeros of $E_2(\chi)$ are either outside the interval $0 \leq x \leq 1$ or occur in conjugate complex pairs. This establishes property (i).

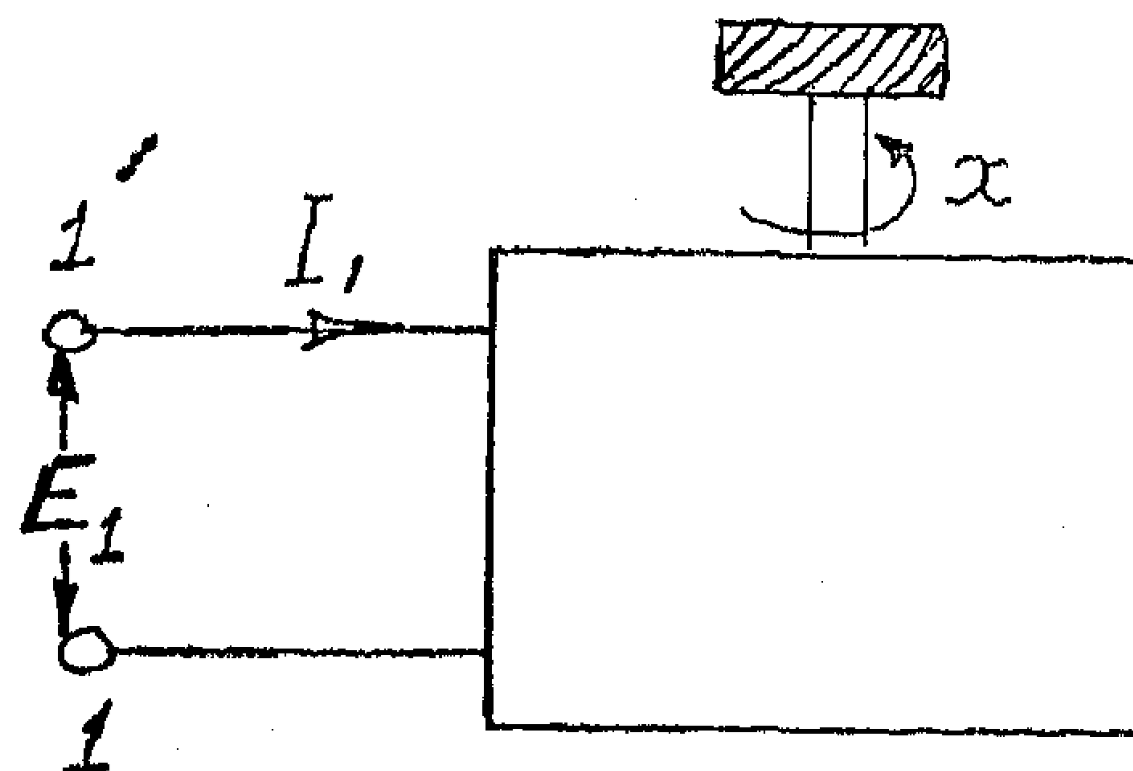


Fig. 3 2-Terminal potentiometer network.

4. PROOF OF PRWPERTY (II) :

We first examine the zeros and poles of the so-called driving-point and transfer resistance.

4.1. The driving-point resistance : Consider a 2-terminal potentiometer network as shown in Fig. 3.

The driving-point resistance is defined as the ratio $R_{11} = \frac{E_1}{I_1}$

R_{11} is a rational function of x. To dis-cuss the zeros and poles of R_{11} we make use of energy considerations. If we consider the network upon loop system, then the energy loss or "dissipation function" F is given by (see, for example, Cauer [6], p. 79 or Guillemin [8], p. 5) :

$$F = \sum_{i,j=1}^{p} r_{ij} I_i I_j = R_{11} I_1 \quad \ldots \ldots \ldots (3)$$

where

p = number of loops in the system,
I_i = current circulating in loop i,
r_{jj} = total resistance in loop j,
r_{ij} ($i \neq j$) = resistance common to loops i and j.
of course rij = rji

(If the loop currents are all assumed positive in the same path direction, clock-wise for example, then all r_{jj} terms are positive and all the r_{ij} ($i \neq j$) terms are negative.)

In a loop system, the loop resistance is a series combination of our resistance elements r_1, χr_2 and $(1-x)r_3$ so that we can write

$$r_{ij} = a_{ij} + x b_{ij} + (1-x) c_{ij} \;, \; a, b, c \geq 0 \text{ and } 0 \leq x \leq 1 \quad \ldots (4)$$

$$F = A + Bx + C(1-x) \quad \text{where} \quad \ldots \ldots (5)$$

$$A = \sum a_{ij} I_i I_j \;, \; B = \sum b_{ij} I_i I_j \text{ and } C = \sum c_{ij} I_i I_j \quad . (6)$$

A, B and C are positive definite*.

* Zeros at the origin or at infinty may occur according to the degree of y in the denominator of $\triangle$ 12 and $\triangle$ 11.

The network of Fig. 1 is considered on nodal system. The ground terminal taken as node O, the other input and output terminals as nodes 1 and 2 respectively. The remaining nodes are identified so that each branch is an $r_1, \chi r_2, (1-\chi) r_3$ in parallel as in Fig. 2. The conductance gjj ($i \neq j$) of the branch between nodes i and j is according to (1) of the form

Fig. 2 Parallel connection of resistance elements

$$g_{ij} = \frac{1}{y}\left(c_{ij} + a_{ij}\, y + b_{ij}\, y^2\right) ; \quad a_{ij}, b_{ij}, c_{ij} \geqslant 0$$

$$\text{Let } g_{ii} = \sum_{\substack{j=0 \\ j \neq i}}^{n} g_{ij} \qquad (i = 1, 2, \dots, n) \qquad (2)$$

where n + 1 is the total number of nodes. (Of course gij = gji and gii has the same form as gij).

The only driving current source is I_1 impressed on node 1. Let E_i denote the voltage at node i measured with reference to the ground node O.

Applying Kirchhoff's current law for the equilizrium of the nodal system, we get (see, for example. Bode [5], p. 12) :

$$\begin{array}{l} g_{11} E_1 - g_{12} E_2 - \dots - g_{1n} E_n = I_1 \\ -g_{21} E_1 - g_{22} E_2 - \dots - g_{2n} E_n = 0 \\ \dots\dots\dots\dots\dots\dots\dots\dots \\ -g_{n1} E_1 - g_{n2} E_2 - \dots + g_{nn} E_n = 0 \end{array}$$

Using Cramer's rule to solve this sys- tem of equations for E_1 and E_2 we get

$$E_1 = I_1 \frac{\Delta_{11}}{D}, \quad E_2 = I_1 \frac{\Delta_{12}}{D} \quad \text{and} \quad E_2 = E_1 \frac{\Delta_{12}}{\Delta_{11}}$$

where Δ_{11} and Δ_{12} are cofactors* of the system determinant D.

$$\Delta_{12} = \begin{vmatrix} g_{21} & g_{23} & \dots & g_{2n} \\ -g_{31} & g_{33} & \dots & -g_{3n} \\ \dots & \dots & \dots & \dots \\ -g_{n1} & -g_{n3} & \dots & g_{nn} \end{vmatrix} = \frac{H(y)}{y^t}$$

* The (ij-cofactor) = $(-1)^{i+j}$ (ij-minor), where the (ij-minor) is the determinant formed by cancelling the row i and the column j in D.

* Note that Δ 12 and Δ 11 may have common factors. When dividing Δ 12 (or H (y)) by such a factor, some coefficients of the numerator of E_2 may become negative.

ZEROS AND POLES OF OUTPUT VOLTAGE OF 3-TERMINAL POTENTIOMETER NETWORKS

BY

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1. INTRODUCTION

In recent years, resistive networks containing fixed resistors and linear potentiometers have been developed for the construction of analogue computing instruments. Greenwood [1] and Speiser [2] show how basic arithmetic operations can be done using potentiometer networks. The work of Abdel-Messih [3] and Abdel Shahid [4] deals with networks containing one and two potentiometers for one and for two variables.

Consider a three terminal network (Fig. 1) containing fixed resistors and a finite number of linear potentiometers mounted on the same shaft. Let x represent the angular displacement of the shaft from one end of the potentiometer winding expressed as a fraction of its full range $o < \chi < 1$,

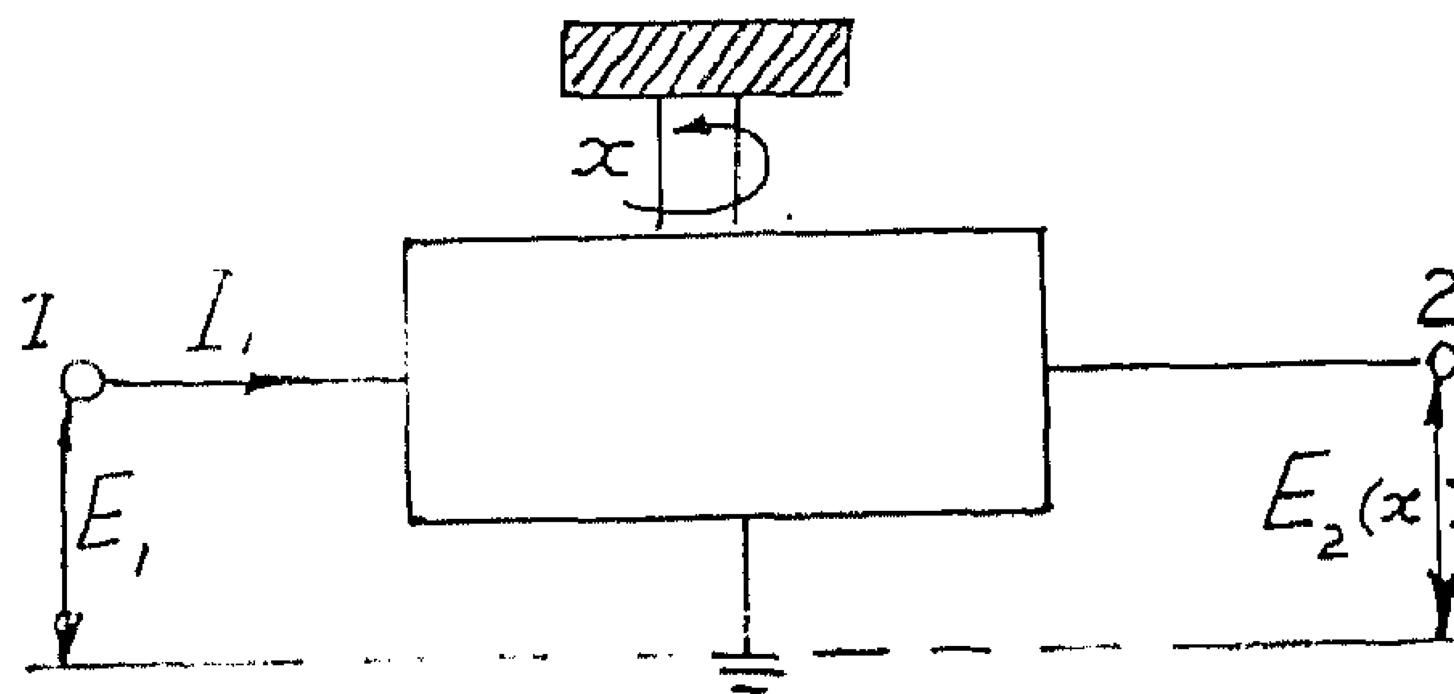


Fig. 1 : 3-terminal potentiometer network

If the network is supplied by a constant voltage E_1, then the voltage at any point of the network, output voltage, is a function of x, Speiser [2] has stated that $E_2(\chi)$ is a rational function of x, which has no poles in the interval $o < \chi <$ and no zeros within $0 < x < 1$.

In this paper we give more precise properities of the zeros and poles of the function E_2 (x), stated in the following theorem, and prove these properties.

2. THEOREM :

The output voltage $E_2(\chi)$ of a 3-terminal potentiometer network is a rational function of x with the following properities :

i — The zeros of $E_2(\chi)$ are either real outside the interval or $0 < \chi$ 1, or occur in conjugate complex pairs.

ii — The poles of $E_2(\chi)$ are simple real negative or ≥ 1.

3. PROOF OF PROPERTY (I) :

In a potentiometer network the resistance elements appear in the form r_1, χr_2 and $(1-\chi)r_3$, where $0 < \chi$ 1.

If three such resistance are connected in parallel as in Fig. 2, then their total conductance is

$$g = \frac{1}{r_1} + \frac{1}{x r_2} + \frac{1}{(1-x) r_3} = a + by + \frac{c}{y} \quad \ldots\ldots\ (1)$$

where $x = \frac{1}{1+y}$, $a = \frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3}$, $b = \frac{1}{r_2}$, $c = \frac{1}{r_3}$ & $a, b, c \geq 0$

* Such networks will be refered to as potentiometer networks A linear potentiometer is that in which the relation between the shaft angle and the variation of resistance between the contact point and one end of the winding its linear.
* The problem is treated in a method analogous to that used by Falkow and Gerst [10] for the transfer function of RC networks.

E.S.T.C. DRILLS V ..COMPETITOR DRILLS T.D. No...971......

Sheet ......of......

..1/4"...Dia. S.S. M.T.S. Speed.......Ft/min=...1,528...R.P.M.

Material: B.S.328 Brinell 207 Coolant: Soluble Oil 40:1 Dilution

Depth of Hole ...3/4"....... No. of Holes for B.S.1...20.........

F. 2526 N.S. Description		Penetration-Inches/Min. 100% B.S.I	120% B.S.I	140% B.S.I	160% B.S.I	180% B.S.I	200% B.S.I	Remarks
					13.65" Feed.			
E.S.C.	1				350+			Capable of further cutting.
(BLUE)	2				350+			- ditto -
COMPETITOR	1				83*			Seized Failed. Outer Corner & Lands.
(BLUE)	2				65*			- ditto -

E.S.T.C. DRILLS V ...COMPETITOR... DRILLS T.D. No. 972

Sheet ....of.......

...3/16" Dia. S.S. M.T.S. Speed.......Ft/min= 1,527 ....R.P.M.

Material: B.S.328 Brinell 207 Coolant: Soluble Oil, 40:1 Dilution

Depth of Hole ..15/32"....... No. of Holes for B.S.1... 24.........

F. 2526 N.S.

Description		Penetration-Inches/Min.						Remarks
		100% B.S.I.	120% B.S.I.	140% B.S.I.	160% B.S.I.	180% B.S.I.	200% B.S.I.	
				14.56"/Feed.				
COMPETITOR	1				16*			Seized. Failed. Outer Corner & Lands.
(BLUE)	2				19*			- ditto -
	3				20*			- ditto -
E.S.C.	1				300+			Capable of further Cutting.
(BLUE)	2				300+			- ditto -
	3				300+			- ditto -

The test billet used for these tests had the following analysis and properties

Carbon	between 0.60 and 0.65 %
Silicon	between 0.15 and 0.30 %
Manganese	between 0.60 and 0.70 %
Sulphur	not more than 0.05 %
Phosphorus	not more than 0.05 %
Nickel) Chromium)	together not more than 0.3%

The steel test billets had a hardness number 200 and 215 HB and a M c Quaid-EHN grain size between number 3 and number 5.

Referring to Journal of Iron and Steel Institute, August 1971, we find from the work of F.A. Kirk, et. al, that in Table 1, the results of comparative drill test using T_1 and M_2 high speed steel.

In addition, tests showed M_2 H.S.S. had increased toughness compared with T_1 H.S.S. the improvement being approximately 30%.

E.S T.C. DRILLS V . COMPETITOR DRILLS T.D. No 975

Sheet of

5/16" Dia S S M.T.S. Speed Ft/min= 1,224 R P.M

Material: B.S 328 Brinell 207 Coolant: Soluble Oil 40:1 Dilution

Depth of Hole 3/4" No. of Holes for B.S.1 20

F 2526 N.S. Description		Penetration-Inches/Min. 100% B.S.I	120% B.S.I	140% B.S.I	160% B.S.I	180% B.S.I	200% B.S.I	Remarks
					13.65" Feed.			
COMPETITOR	1				242*			Seized Failed. Outer Corner & Lands.
(BLUE)	2				220*			- ditto -
	3				190*			- ditto -
E.S.C.	1				300+			Capable of further cutting.
(BLUE)	2				300+			- ditto -
	3				300+			- ditto -

ned in the same manner as the 18-4-1-steel without any precautionary measures.

The consumer can with every confidence use tools made from D MO 5 steel. experience will show a saving in production costs. It has been proved that consumers, stimulated by high production figures achieved with D MO 5 steel, are now raising their standards and demanding from the tool manufactuers tools of the higest efficiency. The most convincing proof of the alround saving a achieved by the use of this high speed steel. There is practically no convincing technical argument for the continued use of the 18-4-1 high speed steel as far as the manufacturer of cutting tools is concerned.

My visit to British Steel Corporation in Manchester on 7.3. 1972 arranged by Dr. D. Griffiths from Mechanical Department, Salford University. we found the following.

1. In these days M_2, H.S.S. (D MO5 H.S.S.) has completely replaced T_I (B H.S.S.) for production of most types of cutting tools.

2. The cost of M_2 is less than T_I due to reduced tungsten content 20%.

3. The standard test proposed in the B.S. specification was observed.

Results for different drill diameter were obtained. showing variations in the performance of M_2 drills from different manufacturers.

E.S.T.C. DRILLS V COMPETITOR DRILLS T.D. No 975

Sheet ... of ...

3/16" Dia S.S M.T.S. Speed. .. Ft/min= 1,527 R.P.M.

Material B S.328 Brinell 207 Coolant: Soluble Oil 40:1 Dilution

Depth of Hole 19/32" No. of Holes for B.S.1 (24)

F. 2526 N.S. Description		Penetration-Inches/Min. 100% B.S.I	120% B.S.I	140% B.S.I	160% B.S.I	180% B.S.I	200% B.S.I	Remarks
					14.56" Feed.			
3/16" Dia.	1				158*			Seized Failed. Outer Corner & Lands.
COMPETITOR	2				104*			- ditto -
	3				119*			- ditto -
3/16" Dia.	1				300+			Capable of further cutting.
E.S.T.C.	2				300+			- ditto -
(BLUE)	3				300+			- ditto

the type D MO 5 high speed steel. Practical tests have shown that this assumption is correct. Proof of this can be confirmed by the user.

The chief reason for the improved efficiency of the D MO 5 high speed steel can be found in the type and behaviour of the differnt carbide mixture. The increased resistance to wear must be, attributed to the increased number of vanadium carbides. The increased retention of hardness is the result of the molybdenum content of the basic mass.

One gains the impression that the effect of molybdenum forms a connection or bridge linking the effect of tungsten to that of vanadium, and that the composition of this steel is so well balanced that it is not possible to substitute any one element for another. The effect of vanadium carbides has for a long time been beyond dispute.. The effect of adding molybdenum has been known for a considerable time.

At the beginning, however, the use of steel with a high molybdenum content presented difficulties. The molybdenum vapourised and the hardening shops had to overcome the difficulty of decarburising and removing molybdenum from the surface of the steel. These difficulites have now been overcome in the manufacture and processing of molybdenum steel. Through the development of hardening salts it was possible to obtain salt mixtures in which molybdenum steel could be harde-

E.S.T.C. DRILLS V ...COMPETITOR... DRILLS T.D. No. ..977.......

Sheet ....of.......

15/32". Dia. S.S. XXXXX Speed...100..Ft/min=....816.....R.P.M.

Material: B.S.328 Brinell 207 Coolant: Soluble Oil 40:1 Dilution

Depth of Hole ...1.3/8"....... No. of Holes for B.S.1..18...........

F. 2526 N.S. Description		Penetration-Inches/Min. 100% B.S.I	120% B.S.I	140% B.S.I	160% B.S.I	180% B.S.I	200% B.S.I	Remarks
					11.7"	Feed.		
COMPETITOR (BLUE)					13*			Failed. Complete Collapse.
E.S.C. STD (BLUE)	1				100+			In good condition Capable of further cutting.
	Test Concluded.							

carbide has a slightly lower hardness. The hardness of the mixed tungsten carbide is considerably less. From the micros the following can be ascertained.

1) The 18-4-1 steel shows numerous large mixed tungsten carbides containg vanadium with a low degree of hardness.

2) The 18-4-2 steel shows mixed tungsten carbides and separate large carbides of pure vanadium with an exceedingly high degree of hardness.

3) D-steel shows fewer mixed tungsten carbides than the 18-4-1 steel, but exhibits in their place pure vanadium carbide.

4) D MO 5 steel also shows pure vanadium carbides and in addition many mixed polybdenum carbides, more numerous than the mixed tungsten carbides, because they are smaller more uniform in shape and evenly distributed. Inaddition, they are harder than the mixed tungsten carbides.

All these carbide-forming elements do not, however, join together to form carbides. In varying quantities they are partially also present in iron, that is, dissolved in the basic mass. During the hardening process of the steel, the types of carbides mentioned do not re-act alike, which means that they require different temperatures and times in order that dissolve in the correct manner as secondary carbides. Without doubt the capacity of solubility of the carbides has changed, owing to tha alloying elements changing the basic mass. Both these factors are especially fevourably co-ordinated in the type D MO 5 steel.

Even from this brief description it can be seen that a particularly high standard of efficiency can be expected from

TABLE 1

Comparative Drill Tests using T_1 and M_2 High-Speed Steels

Test Stage	Speed rev/min	Feed in/min	Drill No. T_1 High-Speed Steel						Drill No M_2 High-Speed Steel					
			1	2	3	4	5	6	1	2	3	4	5	6
1	650	8.8	18	18	18	18	18	18	18	18	18	18	18	18
2	650	10.6	18	18	18	18	18	18	18	18	18	18	18	18
3	650	12.3	18	18	18	18	18	18	18	18	18	18	18	18
4	785	14.1	18	18	18	18	18	18	18	18	18	18	18	18
5	830	15.8	18	18	18	18	18	18	18	18	18	18	18	18
6	870	17.6	18	18	18	18	18	18	18	18	18	18	18	18
7	960	19.4	18	18	18	18	18	18	18	18	18	18	18	18
8	1050	21.1	55	40	11	..	13	3	100	3	99	11	9	21
9	1050	22.9	..	..	..	..	..	..	11	..	..	..	..	..
Total Holes			181	166	137	123	139	129	237	129	225	137	135	147
Average			146						157					

Drills $\frac{7}{16}$ in diameter, manufactured from $\frac{9}{16}$ in diameter bars, blind holes $1\frac{7}{32}$ in. deep drilled in standard test material (BS328), coolant "Dixol" soluble oil in water (1:10)

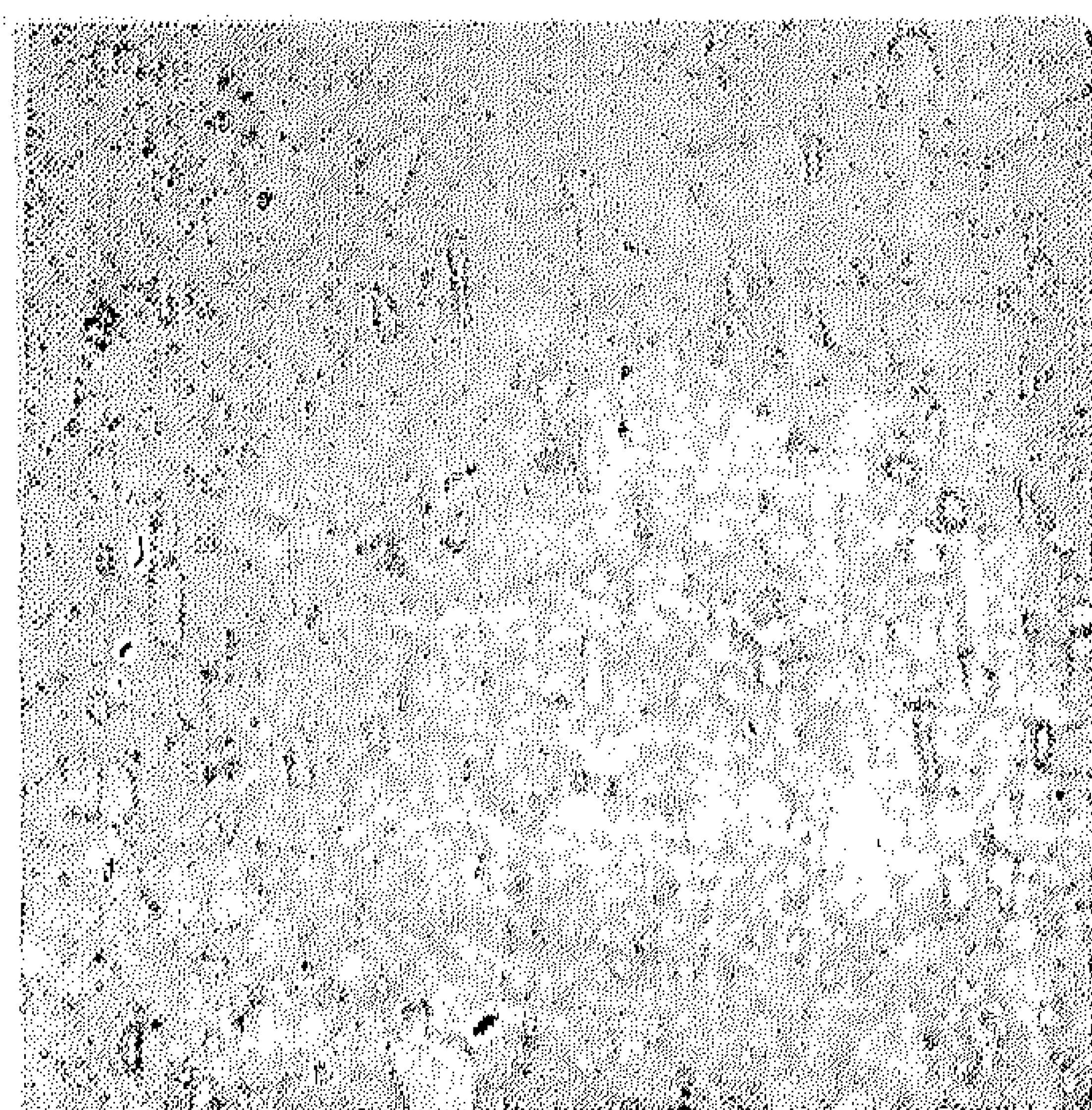


18-4-1

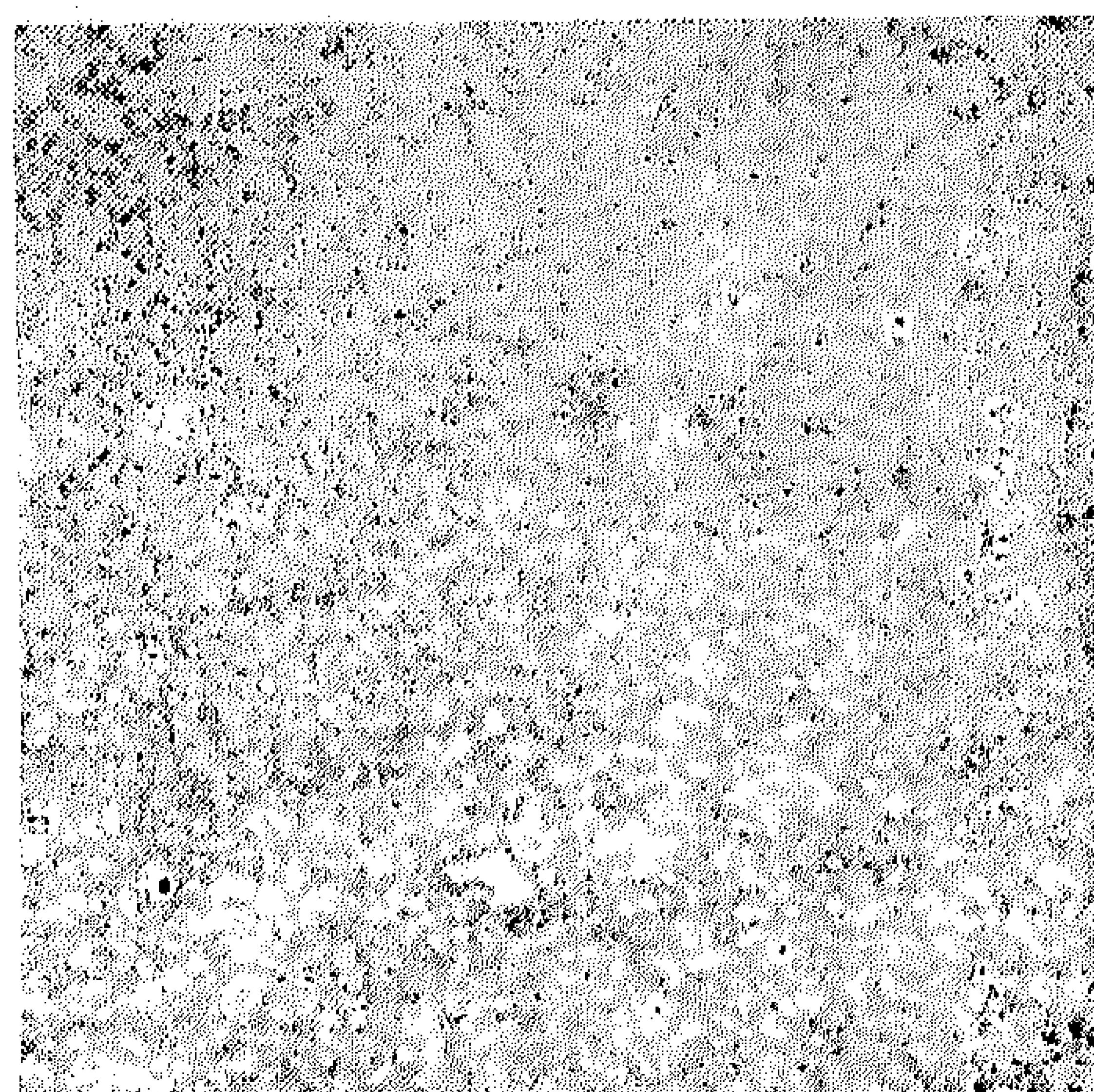


18-4-2

500 * 1



D



D MO 5

As a result of extensive research much information regarding carbides has been made available. Residual analysis points to the complicated composition of carbides with respect to intersolubility, agglomeration and their varied reaction during the heat treatment. Of the various types of steel which have been compared, chromium is present in equal quantities and, ther fore, is non-specific in this case. The large carbides found in the 18-4-1 steel must be regarded as containing tungsten as well as having the largest vanadium content. In the case of the 18-4-2 steel, the number of larger carbides has increased. Pure vanadium carbides have been added which are also found in D- steel. The numerous smaller carbides found in the D MO 5 steel contain molybdenum. It is known that carbides containg tungsten is not pure tungsten carbide, and at its best described as mixed tungsten carbide, and that containing molybdenum described as mixed molybdenum carbide. It is possible that vanadium carbide is present in a pure state, providing the vanadium content approximates 2% and the carbon content is in the correct proportion. Accurate micro-hardness tests of these types of carbide have shown that the pure vanadium carbide is the hardest of all carbides. The mixed molybdenum

NEW HIGH SPEED STEEL

By

Dr. MOHAMED AMIN FARID

Why does a correctly hardened high speed steel retain its characteristics such as resistance to heat, wear and degree of hardness, without loss of elasticity? In the following short survey an attempt is made to explain the nature of high speed steel.

The nature of carbon steel is determined by the proportion of iron to carbon. We will now endeavour to describe the nature of high speed steel according to the type and behaviour of its special carbides and their relation to the basic mass. The steel known as 18-4-1 or "B" steel with its variations (see Analysis after) is the result of long and careful development and is taken as a basic for the purpose of the survey.

Many years ago metallurgists owing to economic conditions, were forced to maintain with only a small percentage of rare metals, a steel equal in quality to the 18-4-1 steel, which at that time was the best obtainable. In spite of poor supplies of rare metals the high standard required of a good quality high speed steel had to be maintained. A new line of research was undertaken by all leading steel manufactuers and research institutes, the results of which were published. The tungsten constituent had to be reduced and where the necessity arose replaced by other rare metals. As a result of the work undertaken, several new types of steel were discovered and are still in use to-day. The foolowing two methods were found to be successful in replacing the effect of Tungsten, which at that time was unobtainable. One of these methods maintained the balance by increasing the Vanadium content and the other by adding Molybdenum.

We will now compare these two new types of steel with the 18-4-2 steel.

	C%1)	W%2)	MO%3)	V%4)	Cr%5)
B 18-4-1 Steel	0.75	18		1	4
B Special = 18-4-2	~	18		2	4
D	0.8-0.85	12	1	2.5	4
D MO 5	0.8-0.85	6.5	5	2	4

1) Carbon, 2) Tungsten, 3) Molybdenum, 4) Vanadium, 5) Chromium.

The alloying element such as tungsten, chromium, molybdenum and vanadium, which are found in high speed steel have all a definite relationship to the carbon. To a greater or lesser degree they form unsaturated carbides, which differ greatly from each other. The differ in size, shape and hardness but as so-called secondary carbides, also vary in their relationship to the basic mass, that is in their reaction during the hardening process. Microscopic examination of hardened samples of the three types of steel mentioned clearly indicates the differences in size, shape and qualitity.

The 18-4-1 shows large and small carbides. The D-steel has a similar structure. The D MO 5 steel, however, shows new types of carbides which are of medium size and equally distributed. The difference in the carbides is till more clearly seen when examining steel containg 18% tungsten and approximately 2% vanadium. It will be noticed that the quantity of carbides has increased.

The relations between the tool cutting angles and the the working cutting angles mathematically and graphically are shown on my next approach. An extension for the thema can be done for measuring the cutting angles in other planes rather than in the measuring planes given in my approach.

CONCLUSION :

A general system is now given which can be applied for all types of cutting tools, besides relation between geometrical and real cutting angles can be determined mathematically and graphically; not only in the measuring planes given but also in arbitrary chosen planes.

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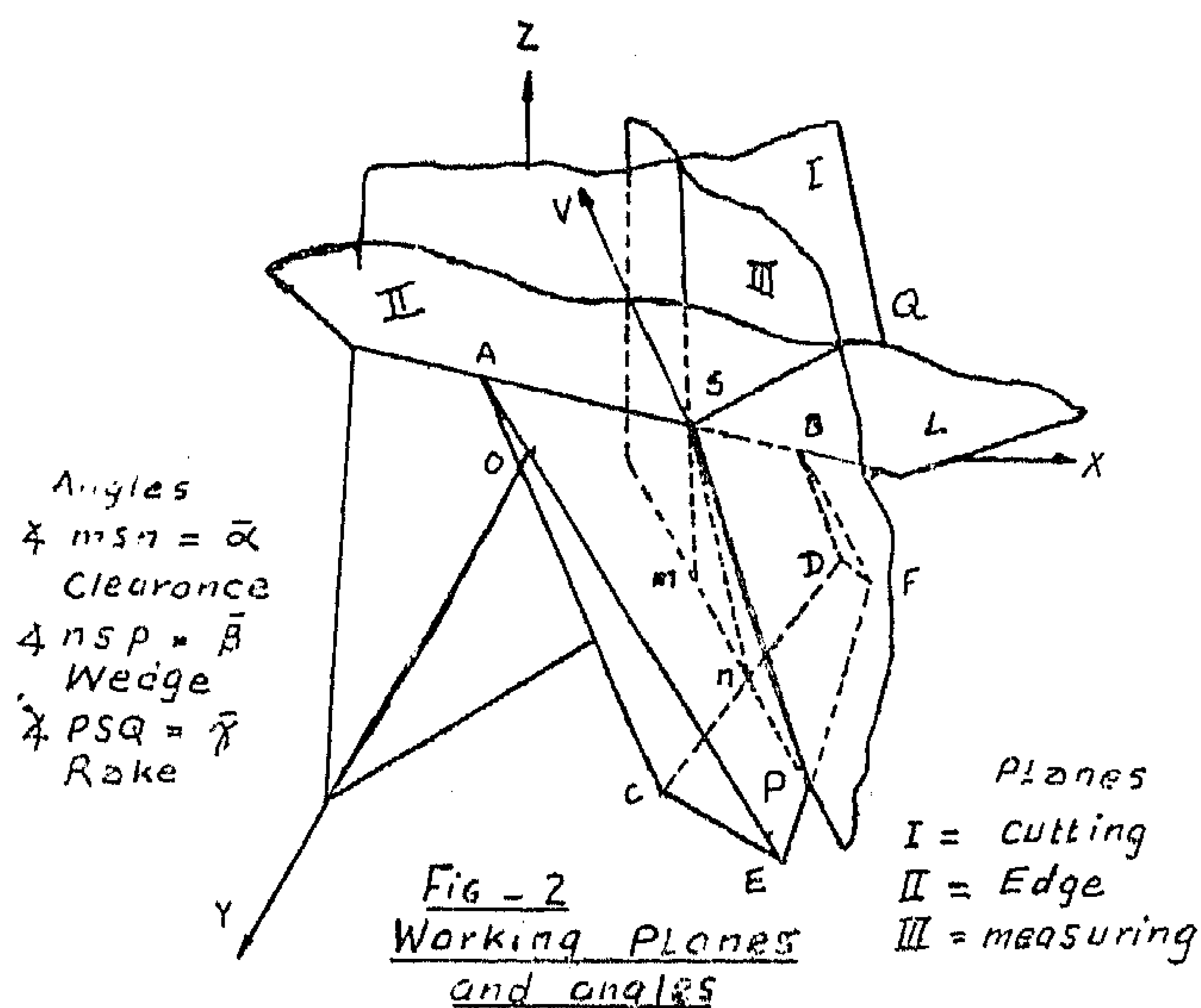


Fig - 2
Working Planes and angles

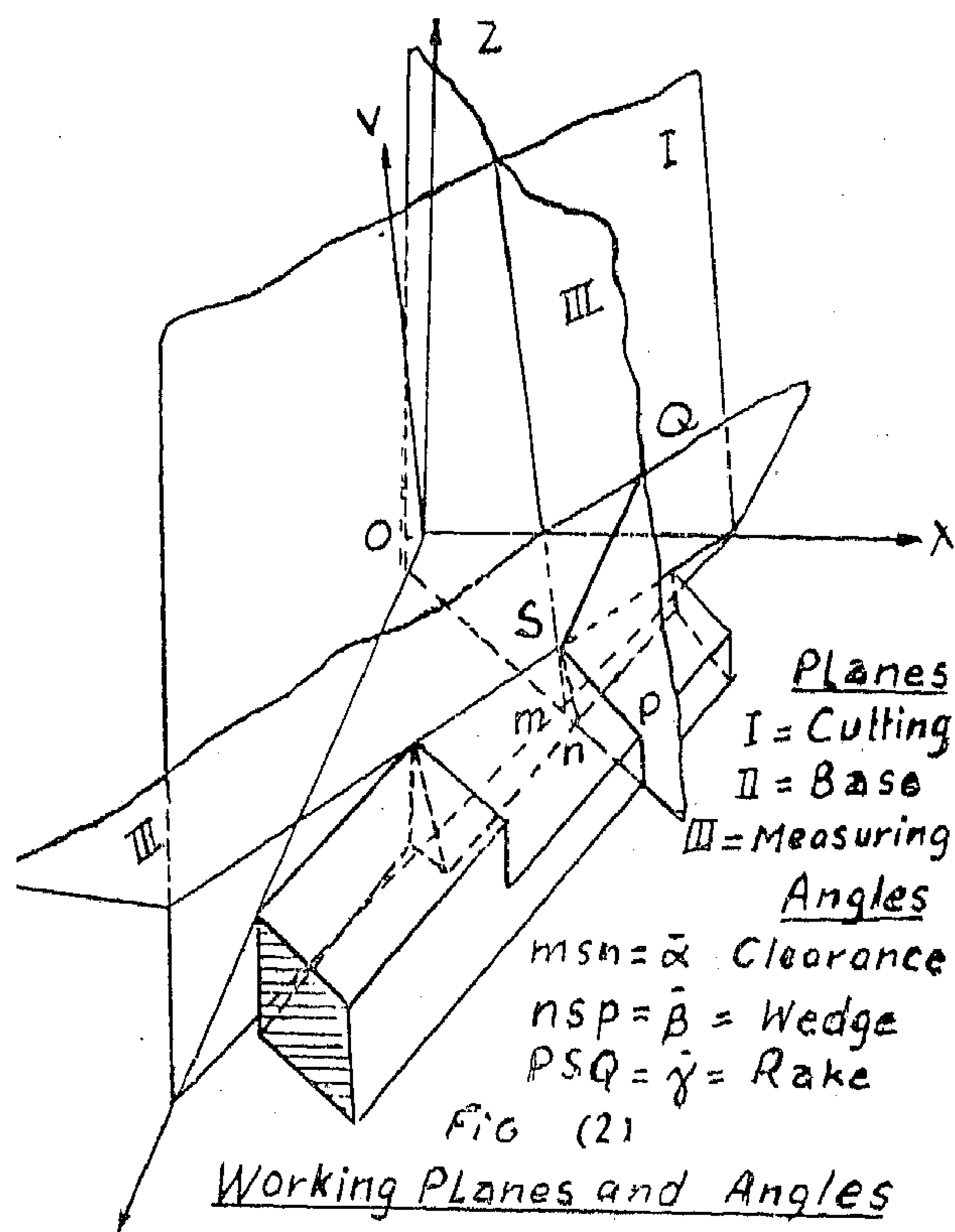


Fig (2)
Working Planes and Angles

Working inclination angle $\lambda_p = \bar{\lambda}$

Is the angle produced by the intersection of the working base plane with the working cutting plane and the working cutting edge plane.

Working side angle (γ_p) = $\bar{\gamma}$

Is the angle produced by the intersection between the working base plane and working cutting plane and the working edge way plane.

Working front angle

Is the same as above only referred to the secondary cutting edge.

Working head (nose) angle ε_p $\bar{\varepsilon}$

Is the angle produced by the intersection of the main and secondary working cutting edges planes and the working base plane.

DISCUSSION

The measuring plane for destinating tool cutting angles is perpendicular to the tool cutting plane and to the tool base plane — On the contrary in the case of working cutting angles, the measuring plane is perpendicular to the working cutting plane and the working cutting edge plane.

This choice for the tool cutting angles leads us to the better design representation and also easier derivation of data from tool drawings for its production.

The main reason which leads us for the choice in the case of the working measuring plane is that the cutting angles measured in this plane are probably nearest to the real conditions during machining - besides it is really possible checking the working wedge angle (B p) directly on the tool (that is perpendicular to the cutting edge).

Is the angle produced by the intersection of the tool measuring plane with the face plane and the tool base plane or the parallel to it.

Tool cutting angle (δ)

Is the angle produced by the intersection of the tool measuring plane with the face plane and the tool cutting plane.

Tool inclination angle (λ)

Is the angle produced by the intersection of the tool base plane with the tool cutting plane and the tool cutting edge plane.

Tool side angle (χ)

Is the angle produced by the intersection of the tool base plane with the tool cutting. plane and the tool edge way plane (XZ).

Tool front angle (χ_1)

Is the same as above only referred to the secondary cutting edge.

Tool head (nose) ange (ε)

Is the angle produced by the intersection of the main and the secondary tool cutting edges planes and the tool base plane.

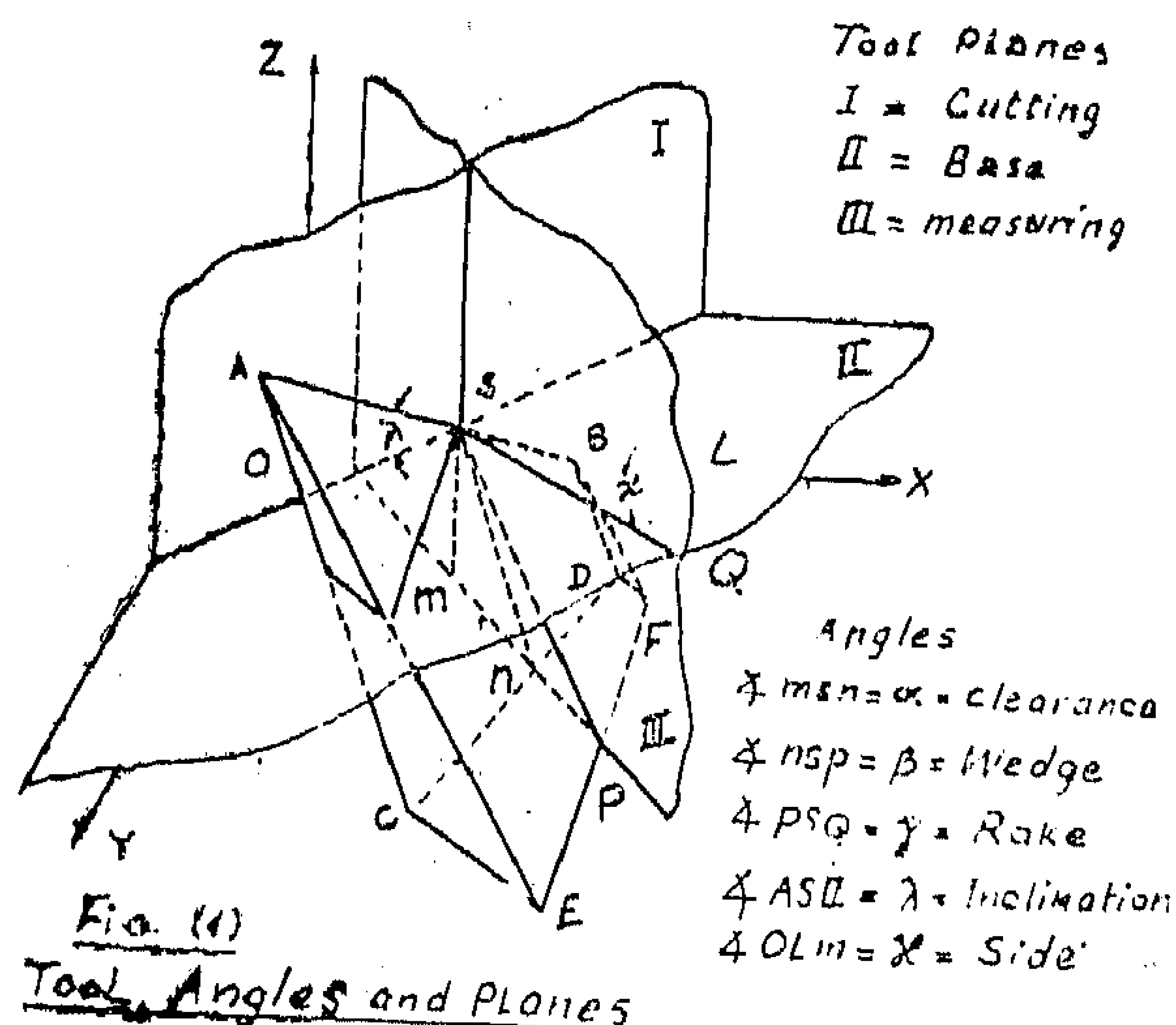


Fig. (1)
Tool Angles and Planes

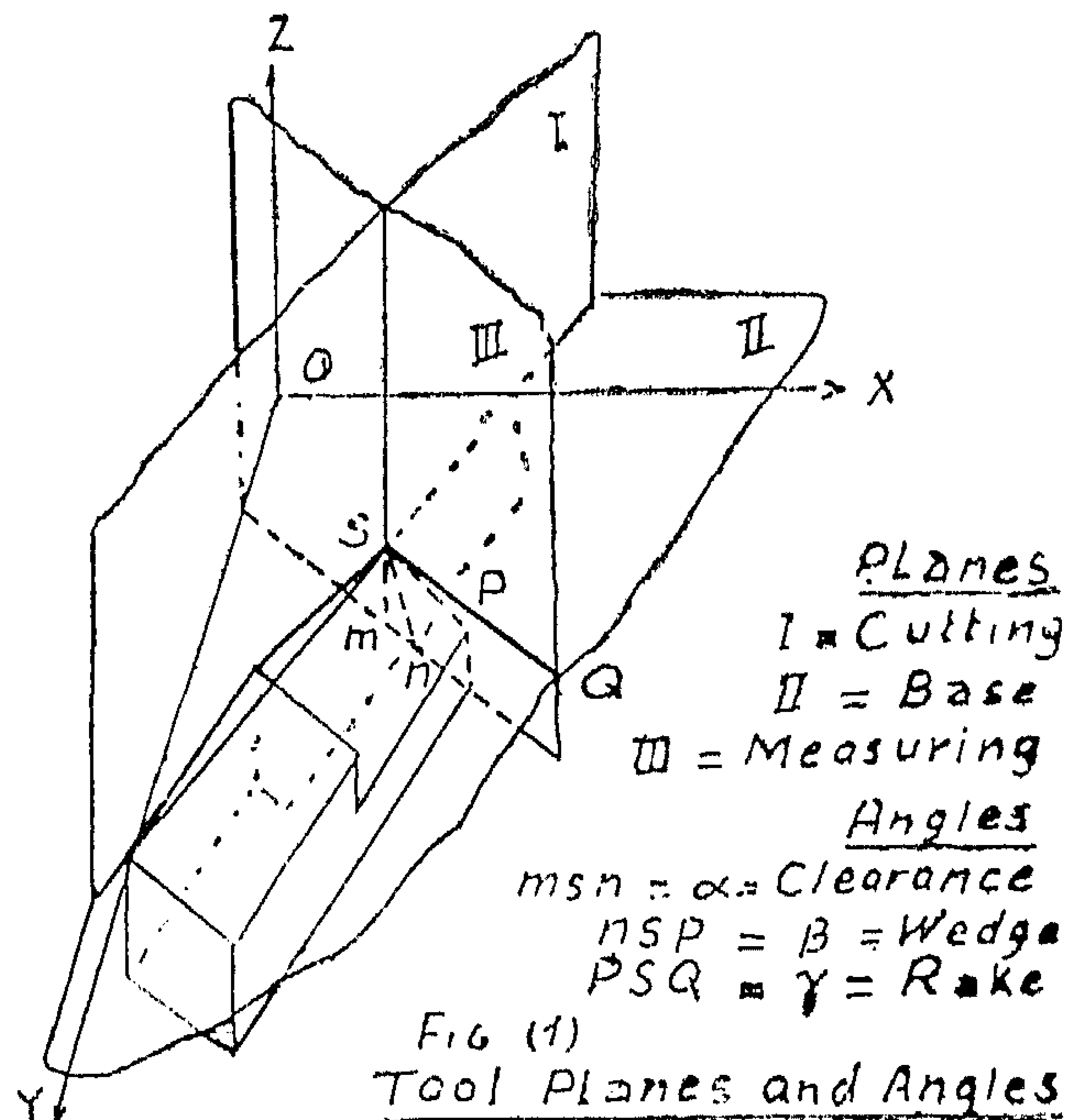


Fig (1)
Tool Planes and Angles

Working cutting angles

Working clearauce angle $\alpha_p = \bar{\alpha}$

Is the angle produced by the intersection of the working measuring plane the tool flank and the working cutting plane.

Working wedge angle (β_p) = $\bar{\beta}$

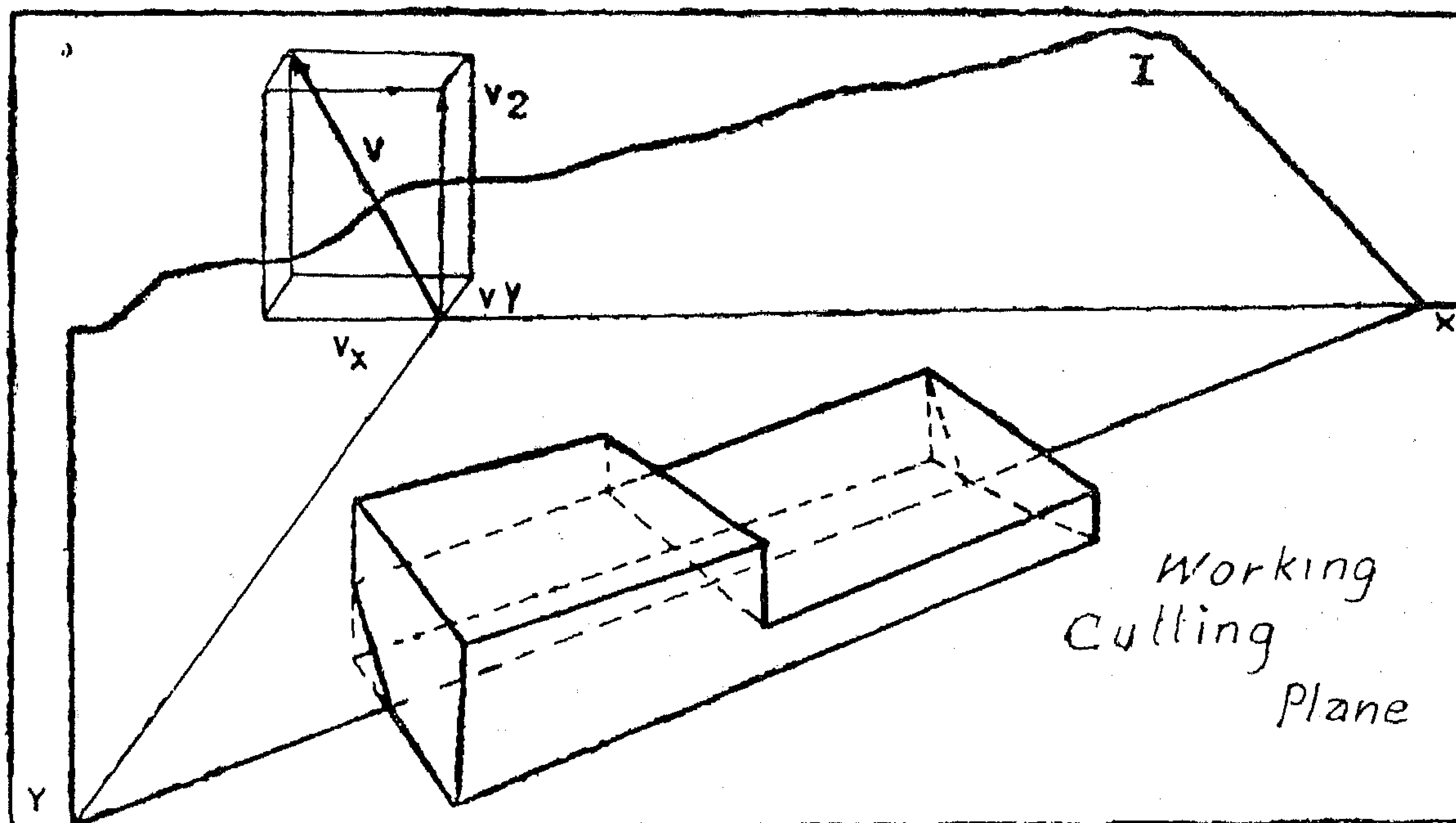
Is the angle produced by the intersection of the tool flank with the face plane and the working measuring plane.

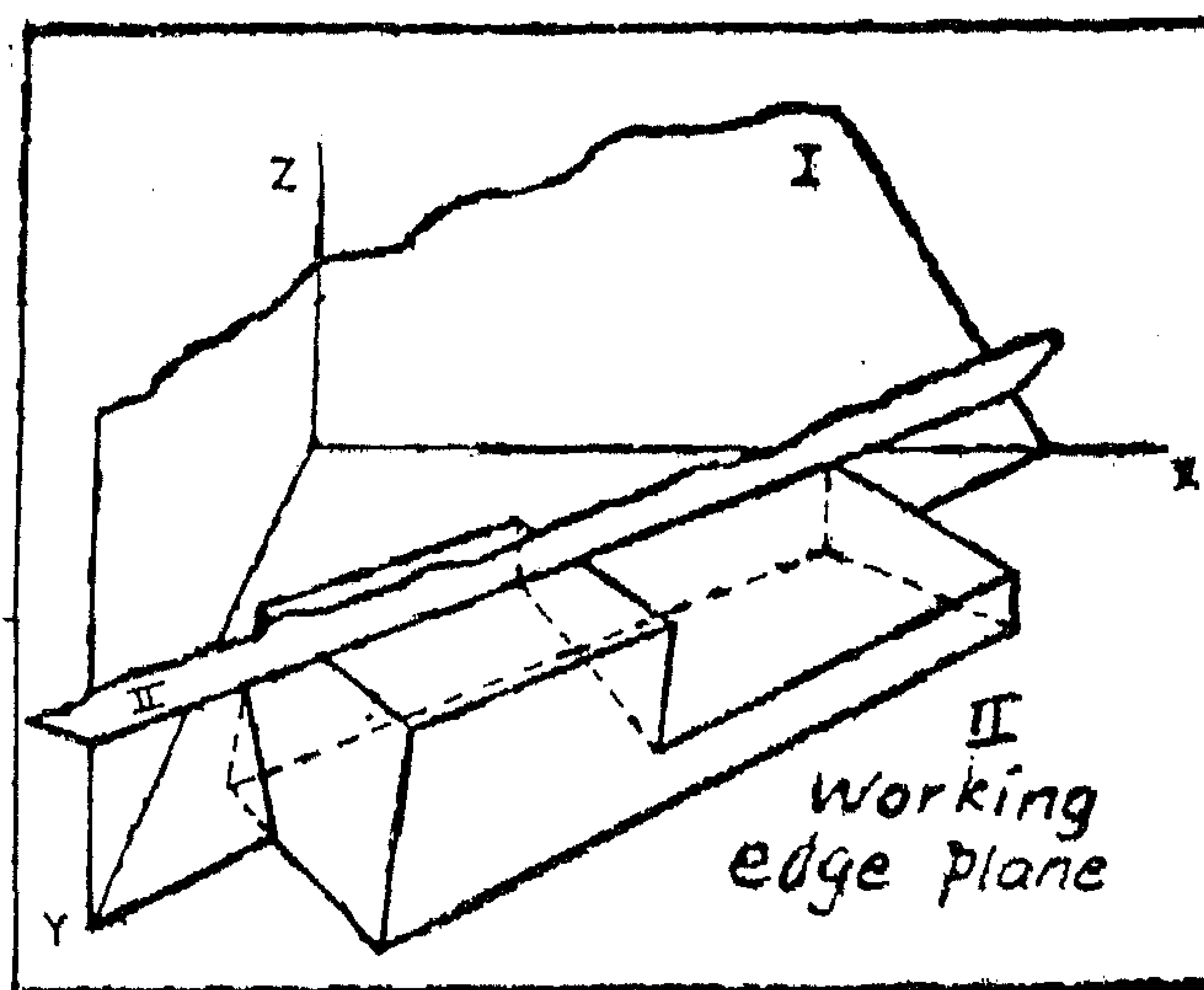
Working rake angle $\gamma_1 = \bar{\gamma}$

Is the angle produced by the intersection of the working measuring plane with the face plane and the working cutting edge plane.

Working cutting angle $\gamma_p = \bar{\gamma}$

Is the angle produced by the intersection of the working measuring plane with the face plane and the working cutting plane.





working base plane

Is the plane perpendicular to the direction of the cutting motion.

working cutting edge plane

Is the plane passing through the cutting edge or tangent to it in the choosed point and normal to the working cutting plane.

Working measuring plane

Is the plane passing through the choosed point of the cutting edge and perpendicular to the working cutting plane and the working cutting edge plane.

working cutting way plane

Is the plane determined by the direction of the resulting cutting motion (V) and the lougitadinal feed (X_x) All these planes are shown in Figure (2).

B — Cutting angles

Tool cutting angles

Tool clearauce angle (α)

Is the angle produced by the intersection of the tool measuring plane the tool flank and the tool cutting plane.

Tool wedge angle (β)

Is the angle produced by the intersection of the flank plane with the face plane and tool measuring plane.

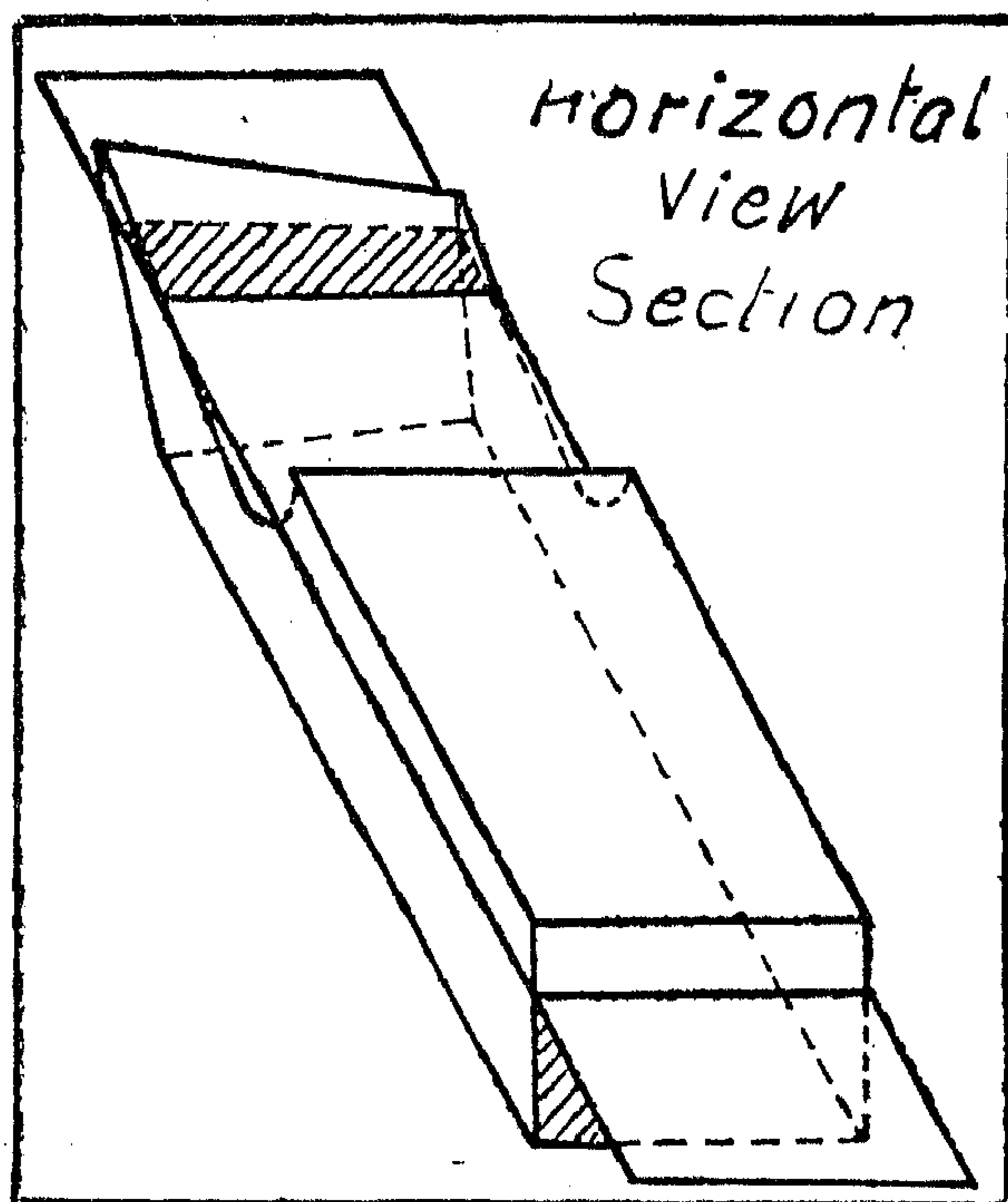
Tool rake angle (γ)

Tool measuring plane

Is the plane passing through the choosed point of the cutting edge perpendicular to the tool base plane and the tool cutting plane.

Tool cutting way plane

Is the plane determined by the direction of the main cutting motion (Vz) and the longitadinol feed (Vx) All these planes are shown in Figure (1).

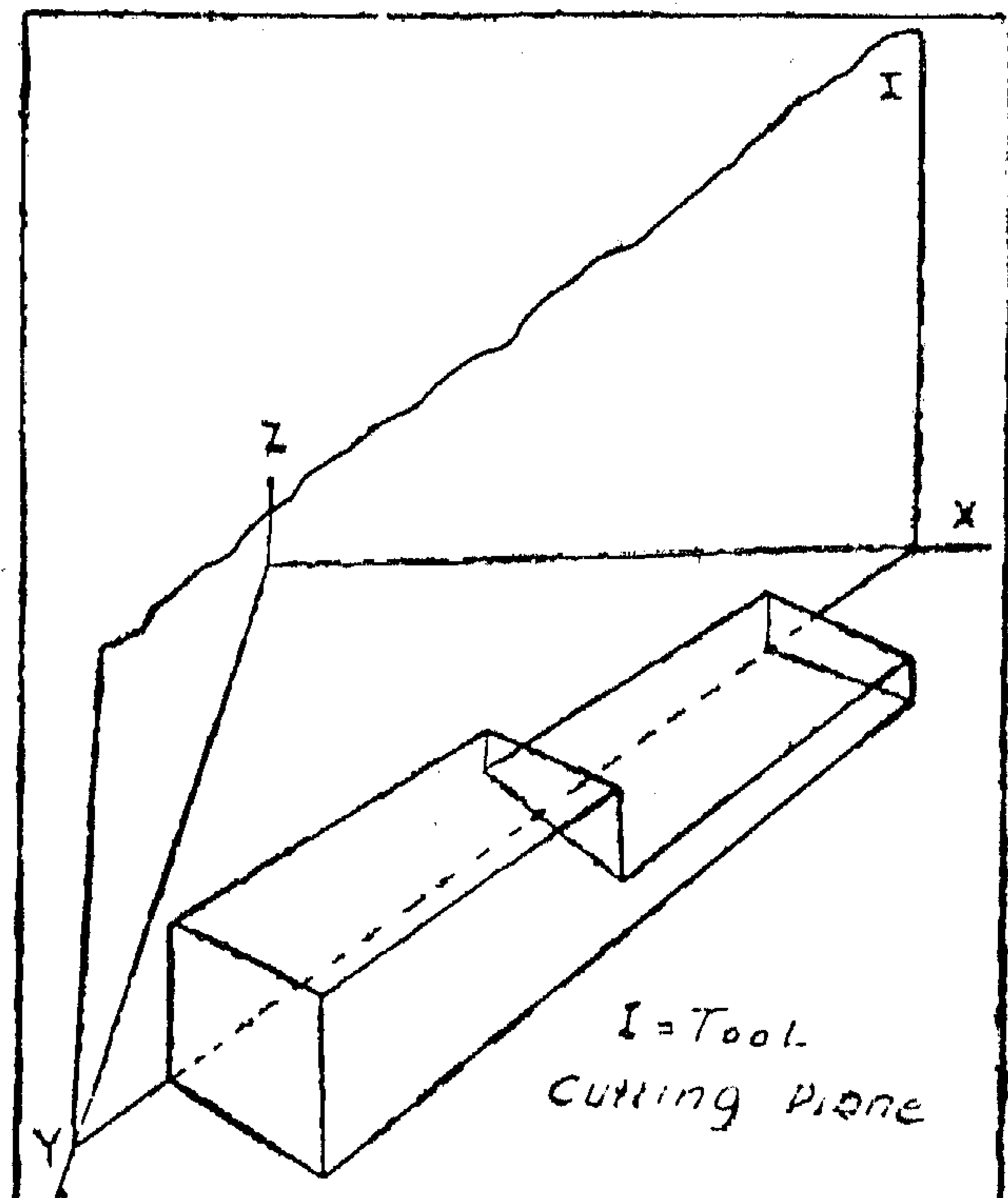


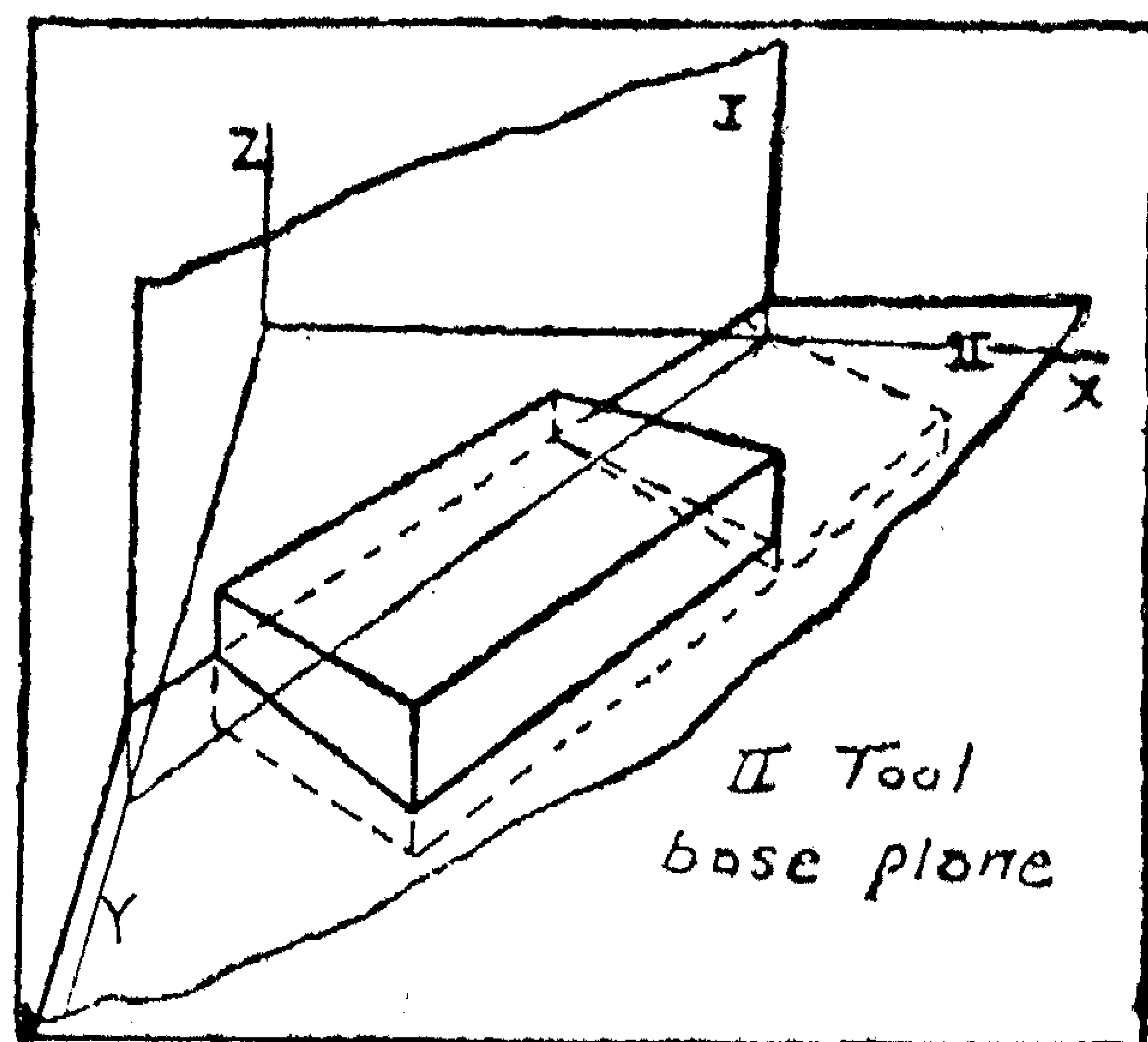
During the cutting operation working cutting plane

Is the plane determined by the main cutting edge or tangent - to it in the choosed point and by the direction of the cutting motion (V).

Secondary working cutting plane

Is the plane determined by the secondary cutting edge or tongent to it in the choosed point and by the direction of the cutting motion (V).





2 — Specify the relation between definitions 1 $_a$ and 1 $_b$.

In order to fullfill all these tasks, begin with the co-ordinates system which is common for both groups under 1a and 1b.

Common co-ordinates system is determined :

a) For tools which have the main cutting motion in a straight line.

axis X- in the direction of longitudinal feed V_x .

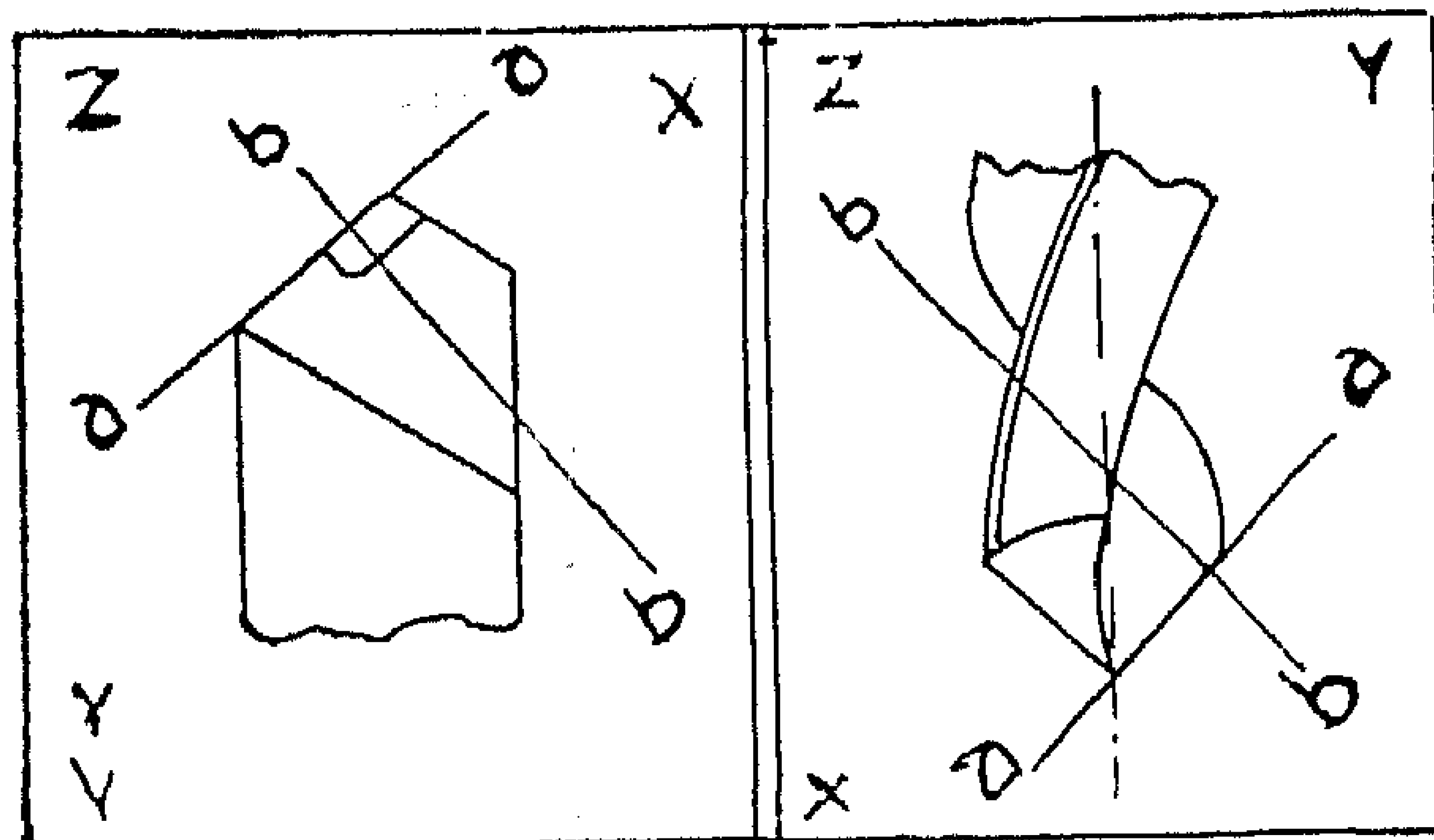
axis Y- in the direction of the cross feed V_y .

axis Z- in the direction of the main cutting motion V_z .

b) For tools having rotating main cutting motions axis X — normal to the plane of rotation from the choosed point.

axis Y — In the direction of the rotating motion plane.

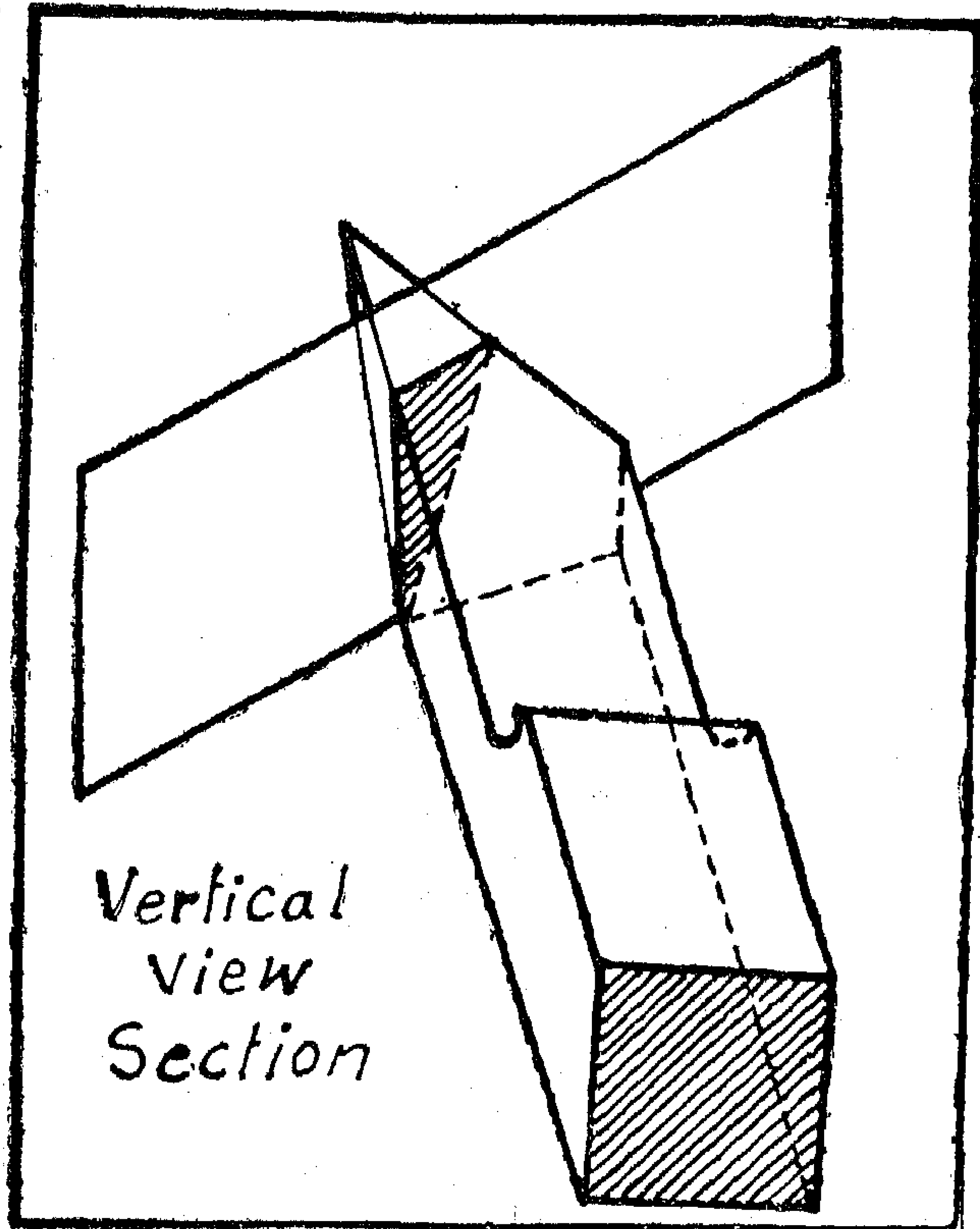
axis Z — The velocity vector of the rotating motion of the tool from the choosed point.



-a- Lathe Cutting tool -b- Twist drill

aa- trace of the tool cutting edge plane
bb- trace of the tool measuring plane
XY- the base plane

Applying this suggested system we can define the elements of the geometry of the cutting tool edges as follows.



A — Planes

with respect to the tool

Tool culting plane

Is the plane passing through the main cutting edge or tangent to it in the choosed point and parallel to the direction of the main cutting motion (with axis Z)

Tool secondary cutting plane

Is the plane passing through the secondary cutting edge or tangent to it in the choosed point and parallel to the direction of the main cutting motion (with axis Z)

Tool base plane

Is the plane perpendicular to the direction of the main cutting Motion (plane XY).

Tool cutting Tool cutting edge plane

Is the plane passing through the cutting edge or tongent to it in the choosed point and normal to the tool cutting plane.

CUTTING TOOIS NOMENCLATURE AND GEOMTBY

part One

By

Dr. MOHAMED ELHADI IBRAHIM ZAKZOUK

INTRODUCTION :

Different systems are known nowadays, that define the cutting tool angles; these systems can be summarized as follows :

a) British system (BS 1886)

The current british system of maxi-mum rake specifies that; by the inclination of the face of the tool over which the chip flows in a plane normal to the base of the cutting tool and in the direction of maximum slope.

b) American system (ASA)

The american system)ASA) specifies the rake plane by giving its inclination in two "vertical+" orthogonal planes one parallel to the axis of the cutting tool and the other normal to it.

c) German system (DIN)

The german system (DIN) specifies two rake angles in "vertical" orthogonal planes, one the back rake in a plane containing the cutting edge (called the cutting edge plane) and the other the side rake in a plane perpendicular to the tool cutting edge plane.

d) Proposed normal rake system

This system is closly related to the german (DIN) system except that instead of measuring the slope of the tool rake face in a plane pependicular to the tool base (as for german side rake), it is measured in a plane normal to the cutting edge, and this slope is termed "normal rake". It is proposed to retain the german "back rake" (which is the inclination of the cutting edge in a plane parallel to this edge. but to rename it "inclination". The inclination refers to the inclination of the cutting edge to the tool base.

In a trial to find a unified system for defining the cutting tools angles applicable for all different types of cutting tools, I put this work.

A new approach for a unified system

General principles :

The determination and design of the main elements of the cutting tool edge, which is made in the form of a wedge penetrating the prossesed material must serve these purposes :

1 — The construction of the tool.

— Production, regrinding and control of the tool.

3 — To specify the relative position between the active elements of the tool (edges and surfaces) and the workpiece during the machining process in order to give a sigle purpose principle for the definition of the cutting process.

Thus for these reasons it is necessary to:

1 — Classify definitions.

a) Definitions indicating the geometry of cutting tool edge from the geometrical point of view.

b) Definition indicating geometry of the cutting edge during the maching process.

INDUSTRY & PRODUCTION

INST. OF MECHANICAL ENGINEERS
INST. OF ELECTRICAL ENGINEERS

ما يجب أن تعرفه عن :

شركة القناة لأعمال الموانى

إحدى شركات هيئة قناة السويس

القاهرة : حي الزهور - مدينة نصر - ت : ٨٣٣٣٠٤ - ٨٣٢٨٦١

— انشئت الشركة فى يناير ١٩٦٥ ، برأس مال قدره (اثنين مليون جنيه مصرى) اصبح الآن ٥ر٢ مليون جنيه .

نشاط الشركة : -

— دراسة وتنفيذ المشروعات الانشائيـــة البحرية ، كحواجز الأمواج والأرصفة والمراسى والقزقات والأحواض الجافة والعائمة والمنائر وعلامات الارشاد وخلافه .

— عمليات القطر والانقاذ والانتشال البحرى .

— أعمال التطهير .

— الحماية الهندسية للشواطىء .

— أعمال مدنية مختلفة فى الداخل والخارج .

اهم الأعمال التى قامت الشركة بتنفيذها منذ تأسيسها : -

(أ) الأعمال المحليـة : -

١ - حواجز الأمواج :

— حاجز أمواج رأس البر .
— حاجز أمواج ميناء البترول بالسويس .
— حاجز أمواج أبى قير .

٢ - أعمال التطهـــير :

— تطهير بوغاز البرلس .
— تطهير وتعميق ميناء مرسى مطروح .
— تطهير ميناء الحمراوين .
— تطهير وصلة ملاحية على ترعة النوبارية .
— تطهير ميناء سفاجا .

٣ - أعمال المـوانى :

— انشاء رصيف ومبنى الارشاد بالاسماعيلية .
— ميناء بور سعيد .
— ميناء الحمـــراوين .
— ميناء الألمنيوم بنجع حمادى .
— توريد كتل دبش لحاجز أمواج أبى قير .
— رصيف أبى قير .
— رصيف مرسى مطــروح .
— أرصفة سفاجا .
— انشاء رصيف لبناء السفن بأبى قير .
— توريد وصب كتل تترابودز بأبى قير .
— انشاء رصيف من الكتل ١٥ - ٢٠ طن بأبى قير .
— امتداد حاجز أبى قير بكتل ٧٠ر× ٧٠ر× ٧٠ر× ، ٢ طن ، ٢٠ طن .
— تبليط أرصفة سفاجا .
— مآخذ وحدات الملوحة بمرسى مطروح .
— حماية الحاجز بالدولز بأبى قير .
— مأخذ مياه على نهر النيل بالتبين .

٤ - أعمـــال القزقات :

— انشاء قزق بورش هيئة قناة السويس ببور توفيق .
— قزق ســـفاجا .
— اصــلاح عواريات بأرصفة ميناء الاسكندرية .

٥ - الأعمـال المدنيـة :

— المرحلة الأولى والثانية من مشروع ناصر لتوســـيع قناة السويس .
— مشروع الرياح الناصرى .
— سحارات بلبيس والشوليا وتابس .
— انشاء خزانين للمازوت بسفاجا .
— انشاء ورشة واستراحة للعاملين بسفاجا .
— سحارة مصرف أبو صوير تحت ترعة الاسماعيلية .
— أساسات ســحارة مصرف العمـــوم تحت ترعـة النوبارية .
— النطاقات الشبكية لحماية الكبارى والقناطر .
— محطة رفع مياه البحر بالحمراوين .
— سحارة مصرف النور الرئيسى .
— الأعمال الترابية والصناعية لمصرف دير السنقورية
— الأعمال الترابيـــة للمناطق الثلاث لمصرف قاطع على مصرف دير السنقورية الرئيسى .

(ب) الأعمـال الخارجية :

بالجمهورية العربية السورية :

— اصلاح واعادة انشاء مكسر أمواج ميناء اللاذقية .
— انشاء ميناء جبلة للصيد بسوريا .
— تطهير ميناء طرطوس بسوريا .
— انشاء الرصيف العميق بطرطوس .

بالجمهورية العربية الليبية :

— توسيع ميناء درنـة .

النقل النهرى يحقق نهضة علمية حديثة

بإنشاء مركز التدريب الإقليمى

شبكة النقل والمواصلات هى مرآة تعكس على الفور تطور الدولة ونهضتها ومواكبتها لروح العصر .. فالنقل مرفق حيوى وهام .. وشبكته .. هى دائما الشرايين التى تزود الاقتصاد القومى بعناصر الحياة أولا بأول .. انها تنقل الحياة فى صورة ركاب .. أو سلع .. أو تجارة .. أو بترول . الخ من قلب الدولة الى أطرافها المترامية .. وتترك هذه الحركة بالطبع اثرها الفورى على كل شيء حيث تدب الحياة وتنتعش التجارة وتزدحم الأسواق الأمر الذى يترك بصماته على حياة الجماهير .

والنقل النهرى يعتبر ارخص وسائل النقل كما يمتاز بقدرته على نقل البضائع والمواد ذات الأوزان والأحجام التى يصعب نقلها بوسائل النقل الاخرى لذلك كان التفكير فى نقل المليون طن من الفحم الحجرى اللازم لمجمع الحديد والصلب من الاسكندرية الى حلوان عن طريق النقل النهرى امرا طبيعيا ولذلك تم تحويل ترعة النوبارية الى مجرى ملاحى من الدرجة الأولى ويعتبر هذا المشروع اضخم مشروعات الثورة فى مجال النقل النهرى حتى الآن .. وقد تم الاعداد له وتنفيذه اثناء الاعداد لمعركة التحرير والنصر .. وقد بلغت تكاليفه ٢٥ مليون جنيه فى قطاع النقل فقط وبهذا العمل العظيم أصبحت الوحدات النهرية تقطع المسافة بين القاهرة والاسكندرية فى ثلاثة ايام بعد ان كانت تقطعها فى عشرة ايام .

ولرفع كفاءة العاملين فى قطاع النقل النهرى

فانه تم الاتفاق على انشاء مركز التدريب الاقليمى للنقل النهرى ويهدف الى تحقيق نهضة علمية حديثة فى مجال النقل النهرى لجميع المستويات ولمختلف التخصصات وستشمل الدراسة بالمركز اعداد طبقة جديدة مثقفة من العاملين بالوحدات النهرية والعاملين فى بناء السفن وصيانتها كما تشمل دراسات تخصصية عليا للمهندسين والماليين والاداريين فى النواحى المتصلة بعملهم بالنقل النهرى واعداد برامج خاصة للمستجدين لرفع مهارة العاملين حاليا بالقطاع .

ويتكلف نحو مليون جنيه مصرى تحملتها المؤسسة بالاضافة الى ٤٠٠ الف دولار تحملتها هيئة برنامج التنمية التابع للامم المتحدة وهى قيمة المعدات والأجهزة العلمية الحديثة وتكاليف المبعوثين المصريين للخارج الذين يقومون بالتدريب فى المركز وتكاليف الخبراء والمعاونين لنا من الأمم المتحدة .

ويقام هذا المركز على مساحة من الأرض تبلغ حوالى ٢٠ الف متر مربع ويتكون من مبنى رئيسى مكون من ثمان طوابق بالاضافة الى صالة للعرض وصالة للمحاضرات وورشة وحمام سباحة ومبنى ملحق به . وقد صممت صالة المحاضرات وجهزت بسقف عرض ٢٤ مترا بدون أعمدة داخلية .

وسوف ينتهى العمل فيه خلال عام ١٩٧٥ بمشيئة الله .

وبعد .. فهذه بعض خطوات المؤسسة المصرية العامة للنقل النهرى والتى تتبعها بمشيئة الله خطوات جادة للتطوير والنهوض بصناعة النقل النهرى بجمهورية مصر العربية التى توليها حكومتنا الرشيدة بقيادة الرئيس المؤمن محمد أنور السادات الكثير من اهتمامها .



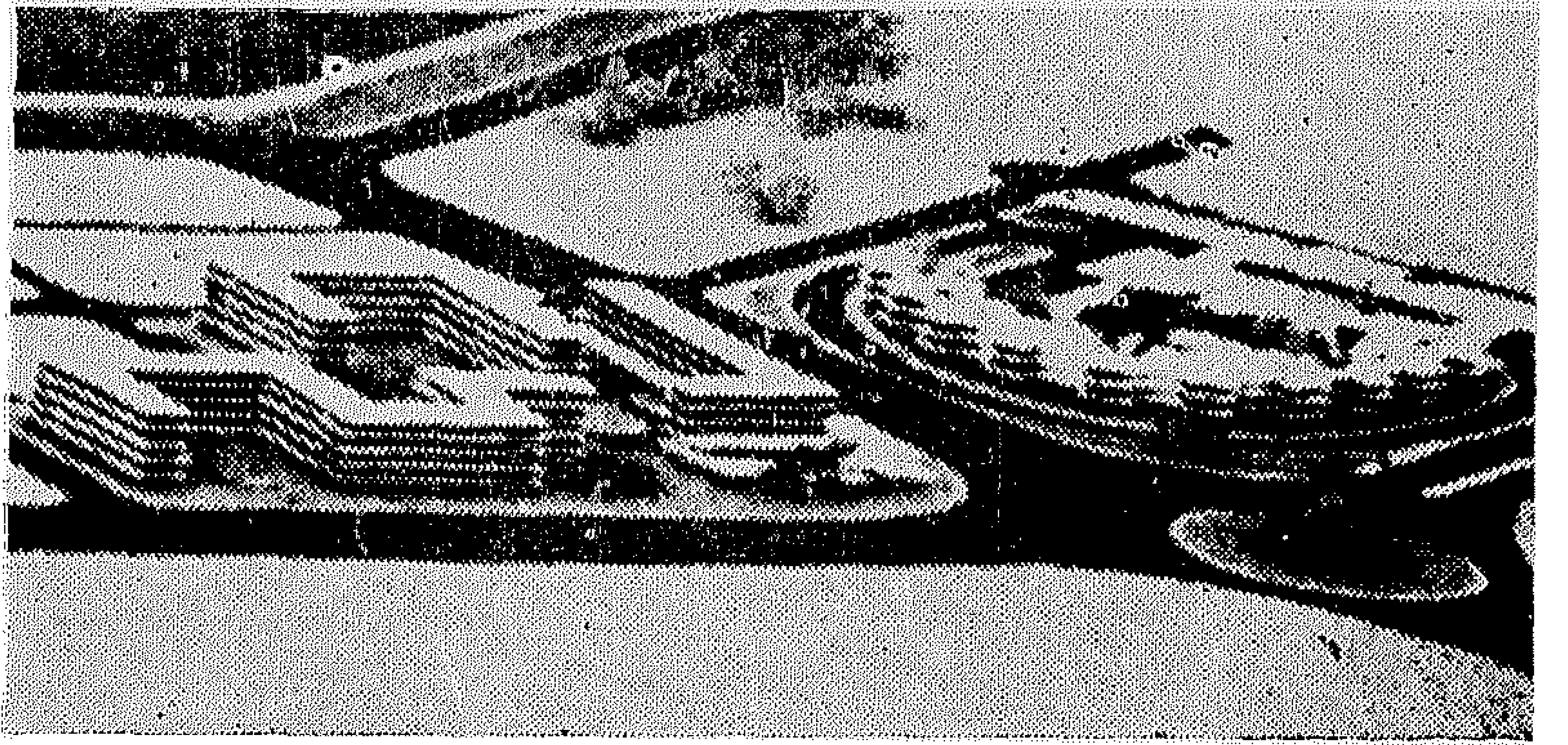
حفاظاً على ايجابيات النصر .. تشارك

شركة الشمس للإسكان والتعمير

إحدى شركات المؤسسة المصرية العامة للإسكان والتعمير

فى مسئولية التنمية والبناء والتعمير

.... انفتاحا على واقعنا الاقتصادى الجديد ونحن ندعم داخليا وخارجيا ايجابيات نصر اكتوبر العظيم عملا وانتاجا .. وأيضا بمفهوم متطور لمسئولية المشاركة فى عملية التنمية والبناء والتعمير .. انطلقت شركة الشمس للاسكان والتعمير تعمد بكل طاقتها لتنفيذ عديد من المشروعات التى اتمت دراستها وبحثها فى ضوء امكانيات تعاون واسهام راس المال العربى والأجنبى .. وذلك ضمن برامج التعمير فى قطاعى الاسكان والسياحة .

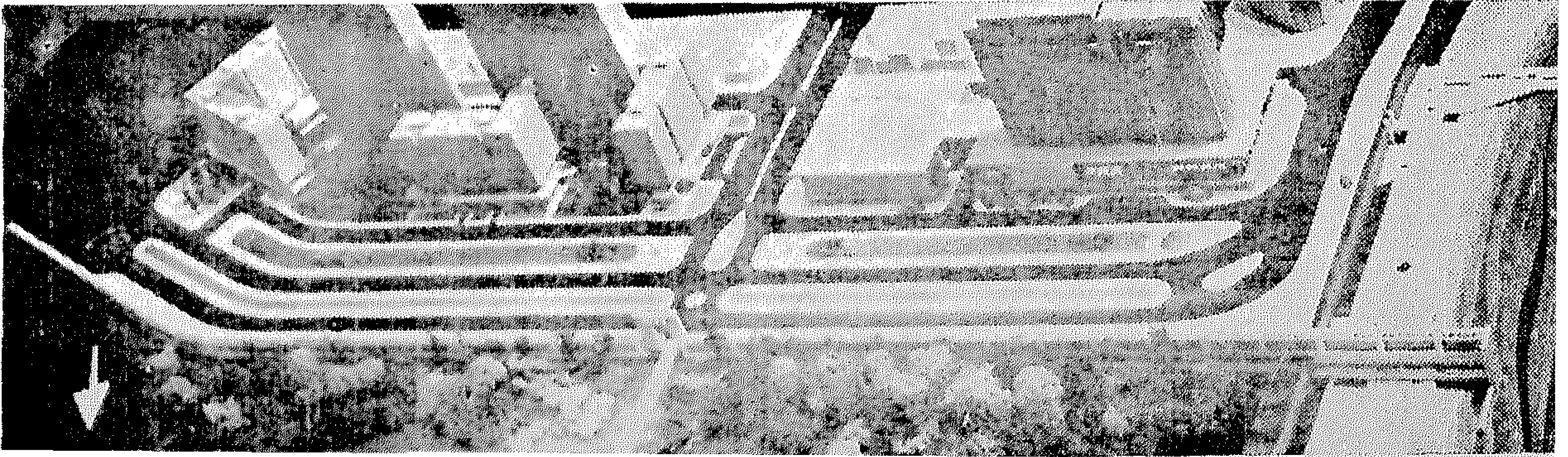


جانب من مدينة الشمس السكنية السياحية بجوار أهرام الجيزة « الموتيلات والمركز التجارى »

.... ومن واقع الدراسات تتضح الصورة متكاملة لأربعة من المشروعات الرئيسية التى تجرى الاستعدادات من الآن لتنفيذها .. والتى سوف تسهم كثيرا فى مجال السياحة والعمران فى بلادنا ... بما تضيفه من امكانيات مادية وعمرانية . وكلمة سريعة مختصرة عن هذه المشروعات ..

● مدينة الشمس السكنية السياحية .. اولى هذه المشروعات بجوار أهرام الجيزة وتقع على طريق مصر اسكندرية الصحراوى وتمتد فوق مساحة ١٠٠ فدان تقريبا .. ووفق أحداث التصميمات العالمية ستضم المدينة مجموعة موتيلات تحتوى على ٣٠٠ غرفة وحمام سباحة وعدد من الملاعب والمطاعم محطة لخدمة السيارات .. كما ستضم أيضا مناطق سكنية سياحية معدة على احدث ما وصل اليه الفن المعمارى وملحق بها كافة الخدمات .. وكذا منطقة سياحية علاجية بها مستشفى ٤٠٠ سرير ودار نقاهة ٢٠٠ سرير وملحق بها مساكن للاطباء والعاملين ..

● مشروع مدينة الشمس بالمنتزه .. على البحر الأبيض المتوسط عبر كورنيش الاسكندرية شمالا ويطل على حدائق المنتزه عبر شارع المنتزه غربا .. ويقام المشروع متكاملا فوق قطعتين من الأرض مساحة الأولى ٩ آلاف متر مسطح تقريبا . .



جانب من مدينة الشمس السكنية السياحية بجوار أهرام الجيزة والاسكان ومنطقة السياحة العلاجية

والثانية ١٢ الف متر مسطح تقريبا .. وبذا يتكون المشروع من مجموعتين . الأولى .. وتشمل فندقا سياحيا ممتازا مع كافة ملحقاته .. ويضم الفندق ٣٥٠ غرفة و ٥٠ جناحا ملحقا بها المطاعم والكافيتريا والمحال السياحية ، وكافة الخدمات العامة . ملهى ليلى وكازينو يطل على حدائق المنتزه حمام سباحة معمى على أحدث طراز .. شاطىء خاص يتصل بالفندق عن طريق نفق سفلى عبر الكورنيش محصور بين سور المنتزه ولسان سيجرى انشاؤه بعمق ٧٠ مترا داخل البحر سيقام عليه عدد من الكبائن وكافيتريا وخدمات سياحية .. قاعة للاجتماعات والحفلات الكبرى تتسع لحوالى ٢٠٠ شخص .. والثانية تشتمل على ٦ عمارات فاخرة ومركز تجارى وخدمات اسكانية أخرى ..

● المبنى الادارى للبنوك والشركات بالقاهرة .. يجرى اقامته بشارع عبد الخالق ثروت وهو لتجميع مكاتب الشركات والبنوك العربية والأجنبية او فروعها وتوفير امكانياتها من حيث الموقع الملائم والخدمات اللازمة دعما للاقتصاد القومى ومساهمة فى توسيع مجال الاستثمار المصرى والعربى والأجنبى ..

● مجمع الشمس الادارى والسياحى بالاسكندرية .. يقع بتقاطع طريق الحرية مع اهم الشوارع التجارية فى وسط المدينة .. ويشتمل على الوحدات التالية :

- فندق سياحى يتكون من ١٥٠ غرفة .
- مبنى يحتوى على وحدات سكنية مفروشة .
- مبنى ادارى لمكتب الشركات ...
- سينما ومسرح .. محلات تجارية .
- جراج من طابقين على كامل المساحة تحت الأرض .

... فتلك على أى حال صورة لبعد جديد من ابعاد العمل الجاد أصبحنا نعيشه بعد انتصار السادس من أكتوبر .

... ان النصر كان حافزا فى ذاته لشركة الشمس للاسكان والتعمير لمتابعة الطريق ... فالواقع الذى تغير بانتصار الارادة العربية كان لابد وأن يصاحبه تغيير فى أسلوب التفكير والعمل والأداء .. واذا كنا ننتهز المناسبة لتهنئة الأبطال الذين بذلوا وأعطوا .. فاننا نعاهد القائد المؤمن الرئيس محمد انور السادات صانع القرار التاريخى أن نخوض معه ومن ورائه معركة البناء والتعمير بنفس الصلابة التى خاض بها معركة النصر والتحرير .. ولسوف تزدهر اذن الله كل الجهود ... لأجل مصر .. وشعبنا العظيم ..



مشروع الفندق والمبانى السكنية بالمنتزه

0000000

المؤسسة المصرية العامة لمقاولات الإنشاءات المدنية

- أولى المؤسسات السباقة إلى تعمير منطقة القناة ... بعد العبور العظيم
- المؤسسة تدخل منطقة القناة لتعمير مدنها للوفاء بآمال الشعب ورفاهيته
- نشاط المؤسسة تعدى حدود بلادنا إلى الدول العربية والآسيوية والأفريقية من أجل حياة أفضل للإنسان في كل مكان .. تمشيا مع العصر الحديث

لسنا دعاة حرب .. لكننا دعاة .. سلام .. فقد كان طبيعيا ان نعمر مناطق القناة بعد العبور العظيم .. ان ما تحقق يوم ٦ اكتوبر .. ذلك النصر العظيم .. جعلنا نبدأ حربا .. اخرى .. حربا جديدة .. حربا .. ضد الدمار .. حربا ضد الجفاف .. وحربا .. ضد توقف الحياة .. ولقد كانت احدى اهداف العدو الصهيونى .. هى ان تتوقف الحياة على ارضنا .. ان تظل معطلة ولا تاخذ مكانها فى التطور العالمى .. ولهذا كان التدمير الذى اراد العدو به .. ان تتعطل الحياة .. بادئا بمنطقة القناة .. ولقد ضرب العدو ثلاثا من المدن الكبرى فى بلادنا .. هى السويس .. وبور سعيد .. والاسماعيلية .. غير مدن اخرى شرق القناة مثل سيناء .. ولقد بلغ التدمير فى مدن مثل القنطرة الى مائة فى المائة .. انه عدو .. ضد الحياة ذاتها .. فالمسالة ليست مسالة عسكرية انها هدم الانسان المصرى هدم بيته .. وارضه وهدم كيانه الاجتماعى ذاته .. ثم جاءت الضربة الرائعة التى حققتها قواتنا المسلحة فى ٦ اكتوبر .. فأذهلت العدو وبعدها مباشرة كان قرار تعمير القناة .. وتعمير .. سيناء ايضا .. سيناء التى غابت عن مصر ستة اعوام .. كان طبيعيا ان يصدر الرئيس القائد البطل انور السادات قراره الحكيم وان يختار خبراء مصريين لتعمير أراضيهم المصرية .

ولقد اختيرت المؤسسة المصرية العامة لمقاولات الانشاءات المدنية بشركاتها وبمهندسيها وبعمالها .. للمساهمة بالتشييد والبناء والعمران فى منطقة القنــاة ..

لكننا سوف نحاول أن نلم ببعض الصور .. من خلال الأنشطة المتعددة .. ومن خلال ما تم انجازه ..

ولعل اول خطوة ، لتحقيق العمل الجيد ، وجود العنصر البشرى الصالح .. فمع وجود كل الخامات المطلوبة .. يظل المهندس والعامل هو الأساس .. فالدرجات عالية المستوى الاشرافى والمستوى الهندسى .. والمستوى الفنى فى جميع العاملين بها والاستخدام الصحيح لهذه المعلومات والمهارات بالاضافة الى التعرف على مشاكل التنفيذ فى المجال العلمى وطرق حلها شركات تغطى اعمال المؤسسة وعددها احدى عشر شركة .

١ – شركة المقاولات المصرية :

تقوم بتنفيذ مشروع الحديد والصلب فى جمهورية الجزائر ، وتصل تكاليفه الى ١٠ مليون دينار جزائرى . كذلك مشروع الانارة الريفية لولايات غرب الريف الجزائرى وتكاليفها ١٠ مليون دينار بالاضافة الى مشروعات أخرى تصل تكاليفها الى ٢٥ مليون دينار وقد استطاعت الشركة بحرصها الشديد وقدرتها أن تتمتع باحترام وثقة .. حكومة الجزائر مما جعلها تنفذ كل هذه الأعمال السابقة أما فى مصر .. فقد قامت بتنفيذ جزء من شبكات السد العالى ومحطة محولات غرب القاهرة وهى تعتبر ثانى محطة محولات فى العالم وتكاليفها ١ر٣ مليون جنيه ، محطة غرب القاهرة وهى اكبر محطة حرارية فى الشرق ، وتكاليفها ٢ مليون جنيه .

مصنع سكر دشنا ٥ر٤ مليون جنيه ، معمل تكرير البترول بالعامرية ٤ر١ مليون جنيه ، مجمع الحديد والصلب بحلوان ٥ر١ مليون جنيه ، محطة كهرباء كفر الدوار ٢ مليون جنيه ، خزانات بترول قنا ٦٠٠ الف جنيه ، محطة مياه شمال شرق القاهرة ٢ مليون جنيه ، مجارى شارع الهرم ٢ مليون جنيه ، محطة مياه التبين ٧ر١ مليون جنيه ، محطة مياه شبراخيت ٧٠٠ الف جنيه ، مستشفى قنا العام ٧٠٠ الف جنيه ، مستشفى سوهاج مليون جنيه ، ورش وجراجات هيئة النقل العام ٢ مليون جنيــه .

٢ ـ الشركة المساهمة المصرية للمقاولات :

تقوم بتنفيذ ٨٢٨ وحدة سكنية فى طرابلس ـ ليبيا تتكلف ٥ مليون دينار ليبى .

وفى الكويت قامت بانشاء قاعدة الصيانة لمؤسسة الطيران الكويتية بمطار الكويت كذلك اقامت مدرسة الشعب ومدرسة حولى ومحطة الطلمبات والمبنى الرئيسى للمواصلات السلكية واللاسلكية بالكويت .

هذا بجانب العمارات السكنية التى أقامتها هناك ...

اما فى مصر .. فان اهم اعمال الشركة المساهمة المصرية للمقاولات تتركز فى :

اقامت مصانع الحديد والصلب بحلوان ، مصنع درفلة الشرائط على الساخن والمبانى المساعدة ومصنع الصوف التوس بكفر الدوار وهو يعتبر أول مصنع من نوعه فى الشرق وتكاليفه مليون جنيه ومصانع الغزل والنسيج بالمحلة ودمياط وكفر الدوار ومصنع الخشب المضغوط بفارسكور . وقد بلغت قيمة اعمال الشركة ٣٨ مليون ، ٨٠٠ ألف جنيه ، هذا بالاضافة الى اعمال أخرى مثل المركز الرئيسى لبنك مصر .. ومستشفى الجمعية الخيرية الاسلامية بالقاهرة . والمدينة السكنية لشركة مصر بكفر الدوار والمدينة السكنية لشركة مصر للحرير الصناعى .

مصنع غزل كفر الشيخ ١٫٥ مليون جنيه ، المدينة السكنية لمصنع الأسمدة ٤٣٢ ألف جنيه ، عمارة النصر بالجيزة ٣٢٠ الف جنيه ، مبنى التشريح بطب القاهرة ٤٠٠ الف جنيه .

٣ ـ شركة النصر للمبانى والانشاءات :

تخصصها فى الأعمال البحرية وخبرتها فيها تصل الى ثلاثين عاما . وتملك الشركة كراكة للتطهير لعمق ٢١ مترا وبقدرة ٥٠٠ متر مكعب فى الساعة . وأهم أعمالها اقامة رصيف الترسانة البحرية وحواجز الأمواج البحرية فى الاسكندرية ، اقامة أساسات مصانع الأليكترونات ببنها والورق الأهلية والنشا والجلوكوز ومحطة الكهرباء بحلوان .. ومصنع تجفيف البلح بالبدرشين ومصنع عصير الفاكهة بأبى كبير ، ومبنى جامعة أسيوط ومساكن الطلبة ومدارس المنيا ومعهد القياس والمعايرة بالهرم .

ومصنع رقائق الألمونيوم ٤٥٠ الف جنيه ، المدابغ النموذجية بالبساتين ١٫٧ مليون جنيه ، مبنى انتاج الأدوية بشركة هوكست ٦٥٢ الف جنيه ، عمليات مختلفة بشركة الترسانة البحرية ٧٠٠ الف جنيه ، رصيف المعدات لمجمع الحديد والصلب بسمالوط ٤٢٧ ألف جنيه ، ومبانى جامعة المنصورة ٤ مليون جنيه .

٤ ـ الشركة العامة للانشاءات :

لعل أهم ما انشأته مفخرة البناء والصحافة .. مبنى مؤسسة الأهرام الجديدة التى بلغت تكاليفها مليون جنيه . يضاف الى ذلك فندق ميريديان الذى يعتبر نموذجا للبناء وليست هذه هى أهم اعمال! فقد اقامت مصانع راكتا للورق بالاسكندرية ومصانع النقل والهندسة بالاسكندرية توسيع مصانع كيما بأسوان . عمارات اسكان مدينة نصر والشيخ هارون وكسير الحجر بأدفو واسوان .

منشأة ٢٣ يوليو السكنية والمؤسسة الاقتصادية بالاسكندرية . مشروع ناصر للاسكان بالحضرة ، المستعمرة السكنية بأسيوط . اساسات كلية الطب ومحطة كهرباء اسيوط . فندق شبرد وابو سمبل ودار الكتب ووزارة الكهرباء ومجمع أسوان ومستشفيات حلوان وشبرا الخيمة وأسوان كما قامت الشركة بتنفيذ الكثير من المنشآت الرياضية، منها مدرجات استاد القاهرة الذى يعتبر أكبر استاد رياضى فى الشرق الأوسط .

ولا تتوقف اعمال الشركة داخل الحدود . انها تتعدى ذلك الى الخارج أيضا . تقوم بانشاء فندق الصداقة بباماكو بجمهورية مالى ـ أساسات عمارة النصر بأبيدجيات بجمهورية ساحل العاج وقد تكلف الفندق ثلاثة ملايين جنيه استرلينى . ويعتبر من أعظم الفنادق السياحية بافريقيا . وكذلك أقامت عمارة شركة النصر بميامى عاصمة النيجر وتكلف المبنى مليون ونصف مليون جنيه استرلينى .

٥ ـ شركة النيل العامة للمقاولات :

لها نشاط فى كل اتجاه ـ فقد قامت بانشاء مصنع نسيج بنى سويف ومصنع الغزل الرفيع بالمحمودية . شركة الورق الأهلية ، كذلك أقامت الترسانة البحرية بالاسكندرية وعدد من الكبارى فى القاهرة وطنطا . مشروع ناصر للاسكان

مستشفى دمنهور العام . المركز الثقافى والاجتماعى بالاسماعيلية .

توسعات مصنع أسمنت طره ٦٨٠ الف جنيه .

مصنع الشفرات المعدنية بالاسكندرية ٤٠٠ الف جنيه ـ مصنع الحراريات والألياف الصناعية ٣٠٠ الف جنيه ـ محطة كهرباء منوف ، محطات محولات قويسنا ، البساتين الزاوية ، الملاك وكل منها بتكاليف ٣٠٠ الف جنيه ـ مخزن الترام المفصلى ١٫٥ مليون جنيه ، مستشفى المنيا العام ٧٠٠ الف جنيه .

وقد بلغت قيمة أعمال شركة النيل العامة للمقاولات أكثر من ١٥ مليون جنيه .

٦ ـ شركة النيل العامة للكبارى :

تختص بالأعمال الخاصة بالكبارى ، سواء كانت علوية أو كبارى ثابتة ، أو كبارى متحركة وقد قامت بتنفيذ ٥٢ كوبريا فى مختلف المحافظات منها كوبرى بركة السبع وكوبرى بحيرة يوسف وكوبرى الاسماعيلية ، وكلها كبارى علوية .

كذلك قامت بتنفيذ كبارى الجمالية وسرسنا ومحلة ابو على . وكلها كبارى متحركة وقامت أيضا بانشاء كبارى فم الخليج وسيالة الروضة والمكس وبحر الملاح ومصرف خيرى وابو قير ومدخل المنيا وكلها كبارى ثابتة . ثم اقامت كبارى صناعية على بحر طناح .

وكذلك هويس لـ ١٠٠ على ترعة النوبارية مليون جنيه ـ كوبرى وهويس لـ ٦١ على ترعة النوبارية مليون جنيه ـ محطات طلمبات الصرف بالمحافظات المختلفة ٦ر١ مليون جنيه ـ مصانع مواسير الصرف المغطى ٦٠٠ الف جنيه ـ جراجات هيئة النقل العام شمال القاهرة ٥ر٢ مليون جنيه ـ نفق شبرا المظلات ٦٠٠ الف جنيه ـ ترعة الخندق الشرقى مليون جنيه ـ هويس المالح والكبارى الملحقة ٣ مليون جنيه .

٧ ـ شركة النصر للأعمال المدنية :

تبلغ قيمة اعمالها اكثر من ١٥ مليون جنيه . وهذه الأعمال تتركز فى أعمال الرى والزراعة ومنها مشروعات تحويل رى الحياض الى رى دائم فى محافظات أسيوط وسوهاج وقنا ومحطات طلمبات الرى والصرف فى شرق ووسط وغرب الدلتا .

كذلك قامت بتنفيذ محطات طلمبات النوبارية رقم ٢ وذلك لاستصلاح ما يزيد على ٢٠٠ الف فدان بالنوبارية . هذا بجوار أعمال الأهوسة والقناطر الكبرى .

وهويس ترعة النوبارية ٨٠٠ الف جنيه ـ هويس فم دياح البحيرة ٢ر١ مليون جنيه ـ مصرف ساقولا الرئيسى وامتداده ٩ر١ مليون جنيه ـ محطة رقم ٥ على ترعة النصر بمريوط ٥ر١ مليون جنيه محولات شرق القاهرة ٥٠ الف جنيه ـ التحكم المركزى بطلخا ٢٥٠ الف جنيه ـ محولات المنشية ٢٠٠ الف جنيه ـ عملية زاوية غزال ١٢٠ الف جنيه .

٩ ـ شركة النصر للمرافق والتركيبات :

تقوم بعمل التركيبات الميكانيكية للمبانى .. بجوار قيامها بتوريد وتركيب محطات الديزل الثابتة والمحركات الكهربائية ولوحة التوزيع ـ واجهزة تنقية مياه الشرب وتنقية مياه المجارى وتصنيع طلمبات مياه الشرب واجهزة اضافة الكلور والكيماويات .. وتقوم كذلك بتنفيذ وانشاء ٢ محطة آبار انتاجية .

وازدواج خط مواسير بسان ٤٠٠ الف جنيه تغذية منطقة الملاك ١١٠ الف جنيه ، مصنع كربونات الصوديوم بالاسكندرية ٦٤٠ الف جنيه الى جانب تركيب محطات مياه كفر الشيخ ٥٠٠ الف جنيه ، اسيوط ٣١٠ الف جنيه ـ محطات مجارى .. كفر الشيخ ٣٨٧ الف جنيه ، المنصورة ٤٣٤ الف جنيه ، مصنع الأسمدة ٢٥٠ الف جنيه ، الفيوم ٢٨٢ الف جنيه . الى جانب تخصصها فى الانشاءات المدنية والأعمال الميكانيكية للمحطات والمرافق العامة والخزانات العالية . كذلك تنفيذ شبكات المواسير وقد نفذت فى هذا المجال محطة رفع واحواض التنقية ومجمعات مشروع المجارى العاجلة المسمى بالمائة يوم بالقاهرة . كذلك انشاء احواض التجفيف بأبى رواش ومحطات مياه بور سعيد والسويس ومشروع ناصر ومريوط .

١٠ ـ شركة المشروعات الصناعية والهندسية :

تعتبر واحدة من اكبر شركات المؤسسة . وذلك لنشاطها حيث نفذت عددا كبيرا من المشروعات منها فى قطاع البترول :

- مشروع رأس شقير . وقد استحقت عنه مكافأة ٣٤٠ الف دولار ، بعد أن نفذت المشروع قبل الموعد المتفق عليه .
- خطوط البترول بين المكس . طنطا . السويس . مسطرد . القاهرة . وطولها ١٥٠ كيلو مترا وقد بلغت تكاليفها مليون ونصف مليون جنيه .
- مشروع العلمين وقيمته ٣٨٠ الف جنيه .
- مصنع هدرجة الزيوت بالمنصورة ٢٥٠ الف جنيه ، المجمع الصناعى بالمنصورة ٣٠٠ الف جنيه ، انارة قرى الجيزة والفيوم ٥٣٠ الف جنيه ، مصنع هدرجة الزيوت بالزقازيق ٤٥٤ الف جنيه ، مركز تدريب هيئة النقل العام بالقاهرة ٥٠٠ الف جنيه ، خط غازات ابوماضى طلخا ٤ر١ مليون جنيه .

اما فى قطاع الرى والصرف فقد نفذت :

- محطة الرفع الرئيسية بمديرية التحرير لرفع المياه اللازمة لزيادة الاراضى الزراعية .
- عملية مياه دمياط المرشحة الجديدة .
- توسيع محطة مياه قناة السويس .

محطات مياه جنوب القاهرة ؛ كوم امبو ٥٥٠ الف جنيه ؛ اسوان ٤٣٥ الف جنيه ؛ جنوب الجيزة ٩٠٠ الف جنيه ؛ المنصورة ٦٥٠ الف جنيه ؛ المنشية ٣ر١ مليون جنيه ؛ شمال حلوان ٧٥٠ الف جنيه .

وفى الاسكان ، قامت بتنفيذ الآتى :

ـــ عمارات سكنية فى كل من اسوان . القبةالأميرية عمال السكر بكوم امبو . فندق كلابشه .

وعلى اية حال فليس هذا هو مجال تعـــداد انجازات المؤسسـة وشركاتها . . فهى كثيرة ومتعددة وفى مختلف المجالات وانما أردنا أن نقدم صورة من كل ميدان من ميادين البناء والتشييدايعبر بضخامة وتفوق عن مقدرة المؤسسة وشركاتها وامكانياتهـا المـادية والبشرية والفنية . . وهذا ما يؤكدهالسيد المهندس احمد طلعت توفيـق رئيس مجلس ادارة المؤسسة .

كلمـــة اخـــيرة

ان الأعمال . . تصـــنع الرجال . . والرجال يصنعون الأعمال العظيمة . . ولقد صنعت المؤسسة المصرية العامة لمقـاولات الانشاءات المدنية بقيادة المهندس احمـد طلعت توفيق رئيس مجلس ادارة المؤسسة . . اعمالا عظيمة . . وهذه الأعمال تستحق التقدير . . وليس تقـدير منصب . . الا أنها تتحمل المسئولية . . المسئولية الضخمة . . هى صناعة حياة جديدة . . كاملة فى أرض القناة وسيناء . . حيـــاة لن تكون عازلة . . داخـــل ذاتها . . وانما مؤثرة ومتأثرة بامتداد أرضنا المصرية وامتـــداد أرضنا العربية والعالم أيضا . . وقدرتها على تحمل المسئولية . . ونحن نثق تماما فى قدرة المهندس احمد طلعت توفيق على العطاء وقدرته على تحمل المســئولية . . وذلك التكريم ومن خلال الأعمال الكبـيرة التى قامت بها المؤسســـة فى جمهوريتنا وخارجها . . سوف يضاف اليها ما سيقال مستقبلا بعد انجازها اعمال التعمـــير فى منطقة القناة وعند ذلك سيضع الشـعب أوسمة ونياشين تعمير وبناء وتشييد على صدر العاملين بها وعلى رأسهم الســـيد المهندس احمد طلعت توفيق .

المؤسسة المصرية العامة للإسكان وشركاتها
قاعدة عريضة لخدمة العمران

تواجه جمهورية مصر العربية تزايدا كبيرا فى عدد السكان ، بلغ فى الربع قرن الأخير حوالى ١٥ مليون نسمة ـ كما واجهت البلاد كثيرا من التحديات ، اقتضت اخلاء أجزاء كبيرة من منطقة القنال من مواطنيها . وبرزت الحاجة الملحة الى تدبير المسكن للمواطنين ، وتطلبت حلولا جذرية وعاجلة .

وفى ظروف تطوير المجتمع ، والاهتمام بنشاط قطاعات كبيرة مثل الصناعة والزراعة ، علاوة على تكاليف الاستعداد لمعركة تحرير الأرض المغتصبة ، انكمشت استثمارات التعمير ، مما جعل المشكلة تتفاقم وتتضاعف أعباؤها .

وامكن بالمال القليل والجهد الكبير أن تنهض المؤسسة المصرية العامة للاسكان والتعمير وشركاتها بدورها الحيوى فى مجالات التعمير والاسكان .

وفى اطار مسئولياتها ، وتنفيذا لاختصاصاتها التى خولها لها القانون ، اضطلعت المؤسسة بواجباتها هى وشركاتها العشرة :

- شركة مصر الجديدة للاسكان والتعمير
- شركة مدينة نصر للاسكان والتعمير
- شركة المعمورة للاسكان والتعمير
- الشركة المتحدة للاسكان والتعمير
- شركة المصاعد ومواد البناء
- شركة التعمير والمساكن الشعبية
- شركة المعادى للاسكان والتعمير
- شركة القاهرة للاسكان والتعمير
- شركة الشمس للاسكان والتعمير
- شركة النصر للاسكان والتعمير وصيانة المبانى

وسارعت ، فى المقام الأول ، بتوفير الأراضى الصالحة للبناء ، وتزويدها بالمرافق ، وفق خطة مدروسة ، حتى تساهم فى تحقيق خطة الدولة ، واستيعاب المبانى والانشاءات الخاصة بمشروعاتها ، سواء للاسكان ، أو الصناعة ، أو السياحة ، أو التعليم او غيرها .

وأثمرت هذه الجهود عن أعمال ملموسة ونتائج طيبة :

● اذ قامت المؤسسة بتخطيط مناطق سكنية متكاملة المرافق مثل استحداث وانشاء مدينة نصر ، وتخطيط وتنفيذ امتدادات ضاحية مصر الجديدة ، والمعادى ، وحدائق الأهرام ، والمعمورة وغيرها ـ وبدأت عملها بتوفير أسباب العمران بها ذلك بتمهيد الأرض وتسويتها ، وشق الطرق بها ، وتزويدها بشبكات المرافق ، واقامة بعض المبانى السكنية ومبانى الخدمات الأساسية كنواة ضرورية لجذب العمران .

وكانت محصلة هذه الأعمال الانتهاء من تعمير حوالى ٦٤٠٠ فدان ، بجانب اقامة وحدات سكنية ، بلغت ١٥ ألف وحدة سكنية تكلفت حوالى ٣٠ مليون جنيه ، بخلاف انشاء مبانى خدمات الاسكان فى كافة الأنشطة من تعليمية وثقافية ودينية واجتماعية ورياضية وتجارية وترفيهية وخلافه .

● وقامت بتصميم نماذج الاسكان بمستوياته من اقتصادى ومتوسط ، بهدف توفير المسكن الصالح للمواطنين ، ويجرى تنفيذها حاليا بالمحافظات .

● كما قامت المؤسسة بتخطيط وتعمير بعض المناطق السياحية كشاطىء المعمورة وشاطىء العجمى بالاسكندرية ، وتزويدها بالمرافق والمنشآت السكنية والسياحية ومبانى الخدمات الضرورية تمهيدا للانطلاق فى باقى المحافظات .

● ولصيانة الثروة العقارية التابعة للدولة ، ممثلة فى مبانى السكن والمبانى العامة والمملوكة للقطاع العام ، خصصت المؤسسة احدى شركاتها لاجراء أعمال الصيانة الدورية والعاجلة اذا طلب منها ذلك .

● كما تتولى رسم سياسة توفير المصاعد لقطاع الاسكن والمبانى العامة وصيانتها ، بأن خصصت احدى شركاتها لهذا الغرض ـ وتقيم حاليا مصنعا للمصاعد بالقاهرة بالاشتراك مع كل من شركة شندلر السويسرية ، ورأس المال العربى .

● ولتعميم خدمة المؤسسة وشركاتها على مستوى الجمهورية ، فقد تم وضع تقسيم جغرافى لنشاط الشركات ليتحقق امتداد نشاطها الى سائر المحافظات ، فتقوم اذا ما طلب منها ، باستحداث أحياء كاملة بمدن المحافظات تتمتع بكامل خدماتها ، وفق التخطيط العام للمدن ـ من ذلك ما تقوم به حاليا من تخطيط لمناطق العمران الجديدة بطنطا ومدينة أبو حمص بالبحيرة .

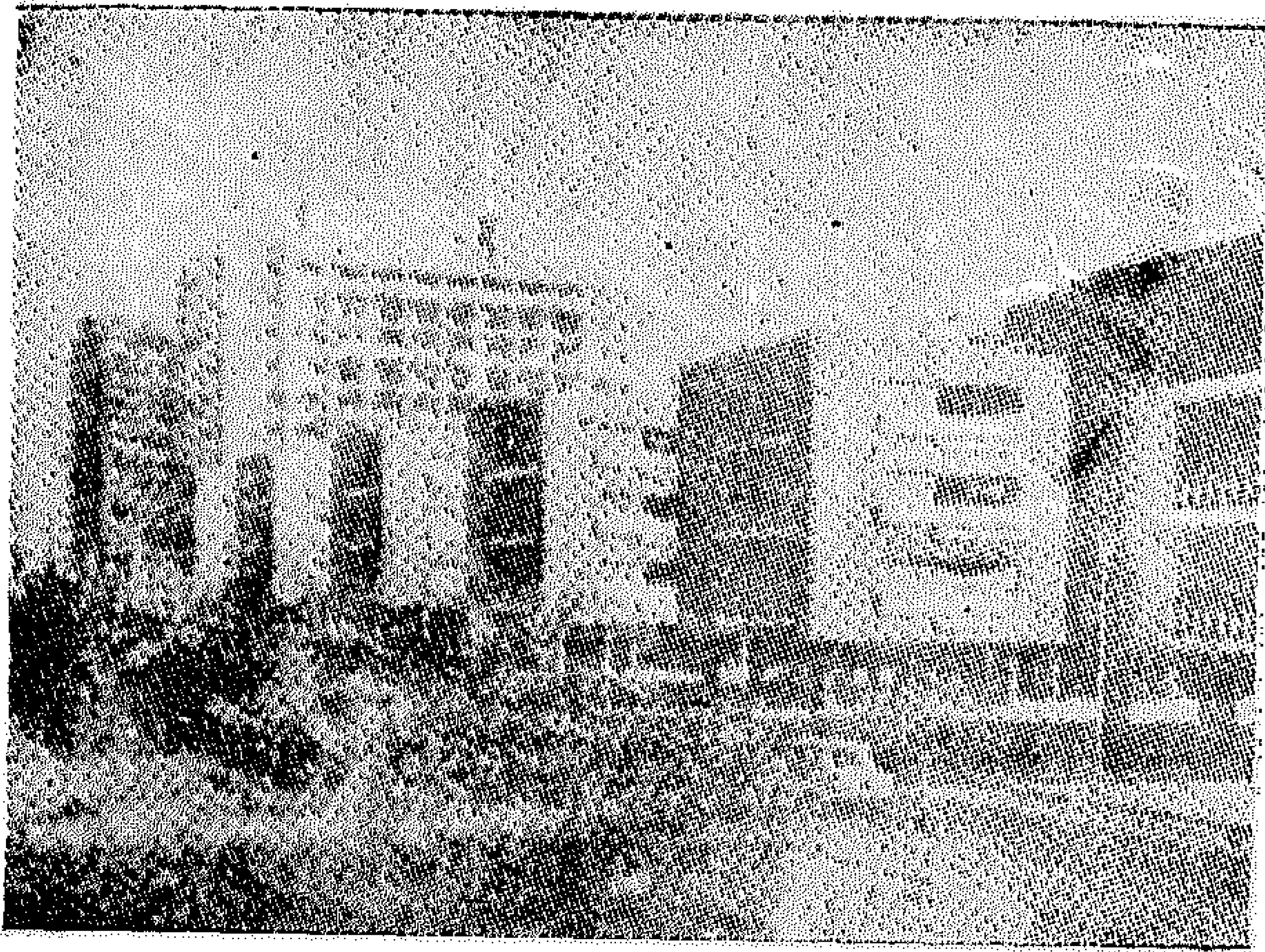
● ومن الأنشطة التى تتناولها المؤسسة اقامة المساكن للتمليك ، مما يحقق لجماهير المواطنين الانتفاع بالمزايا العديدة التى تقوم عليها سياسة التمليك ومنها :

ـــ تحقيق أمل المواطنين الطبيعى فى تملكهم للمسكن الذى يقيمون فيه .

ـــ تأكيد المفهوم الاشتراكى السليم بتدعيم التضامن المشترك بين ملاك المبنى الواحد فى الادارة والصيانة .

ـــ الاسهام بالتمويل المباشر ، ودوران رأس المال ، لانشاء مساكن جديدة ، بهدف توسيع قاعدة التمليك ــ ذلك مما يساعد على تشغيل مدخرات الأفراد واستثمارها فى نشاط ايجابى مثمر .

● ولمواجهة الزيادة الحالية والمرتقبة فى سكان اقليم القاهرة الكبرى ، فقد قامت المؤسسة وشركاتها باعداد الدراسات اللازمة لانشاء بعض المدن الجديدة التى تقررت اقامتها لاستيعاب جزء من هذه الزيادة السكانية ، على أن تكون هذه المدن مستقلة استقلالا ذاتيا من حيث المرافق العامة والخدمات .



● وامتد نشاط شركات المؤسسة لخدمة مشروعات التقدم العمرانى فى انحاء الوطن العربى ، ونذكر على سبيل المثال قيام شركة التعمير والمساكن الشعبية ــ احدى شركات المؤسسة ــ بخدمة انطلاقه التقدم والعمران فى الجمهورية العربية الليبية ، فأقامت اعمالا قيمتها التقديرية اكثر من ٣٠ مليون دينار ليبى ، تشمل اقامة المستشفيات والمراكز الصحية والفنادق السياحية ومبانى الخدمات العامة هذا بخلاف نشاطها فى الجمهورية العربية السورية الذى بلغ حجمه حوالى ٥ مليون ليرة .

الخامات الأولية
والصناعات الكيميائية

جمعية مهندسى المناجم والبترول
والفلزات
جمعية المهندسين الكيميائيين

في مجال الصناعات البتروكيماوية

صناعة الفورمالدهيد بأقل التكاليف

للمهندس / ابراهيم محمد عزاوي

مقـــدمة :

دخلت منتجات البلاســـتيك كل منزل في صور عديدة كما دخلت كثير من الصناعات بأشكال مختلفة — وكلمة بلاســتيك عامة تجمع أنواع كثيرة في هذا المجال يهمنا هنا أنواع خاصة منها وهي :

اليوريا فورمالدهيد والفينول فورمالدهيد وهما أساس صناعة كثير من الأدوات المنزليـة وصـناديق الراديو والتليفزيون والتليفون . وكذلك مادة الميلامين فورمالدهيد وهي أساس صناعة الأدوات المنزليـة الغير قابلة للكسر ، والفورمايكا — ولتعريف الفورمايكا بصــورة مبسطة ، فهي عبارة عن عدد معين (حوالى ٧) من أفرخ ورق بالمساحات المطلوبة ، يتم غمسـها في محلول خاص من الفينول فورمالدهيد وتجفف وكذلك فرخ ورق بنفس المساحة ومزركش بأي نقوش أو ديكور حسب الطلب كمـا نراها فوق ألواح الفورمايكا التي بين أيدينـا ، ويتم غمسه في محلول الميـلامين فورمالدهيد ثم تجفيفه ثم توضع الأفرخ المغموسة في الفينول فورمالدهيد فوق بعضها وفوقها الفرخ المزركش المغموس في الميلامين فورمالدهيد وتدخل مكابس سـاخنة خاصـــة ، تصل الى درجـــة حـرارة وكبس معينة ، عندهما يتم الشك بين الجزئيات (كما يحدث في تجمد الأسمنت) لتنتج بلمرات عالية، تعطي خواص البلاســتيك الملموسة من ناحيـة المتانة واللمعية وبذلك يمكن القول أن الفورمايكا تكون من ســطح من الميـلامين فورمالدهيد غـير قابل للحريق أو الكسر ومزركش حسب الطلب، وأسفله فينول فورمالدهيــد تعطي قوة وتقلل التكاليف فهي أرخص من الميلامين فورمالدهيد.

من ذلك يتضح أن الفورمالدهيــد عامل مشترك في صـناعة ثلاث مواد هامة من مواد البلاستيك . بالاضافة الى أهميتهـا في الطب وعمليات التشريح بالذات حيث أن محلولها في المـاء يعتبر وسط ملائم لحفظ الجثث ولمـدد طويلة .

والفورمالدهيد هو مادة كيميـــائية رمزها الكيميائي ك يد ٢ ا وتركيبها البنائي ك يد / يد ا .

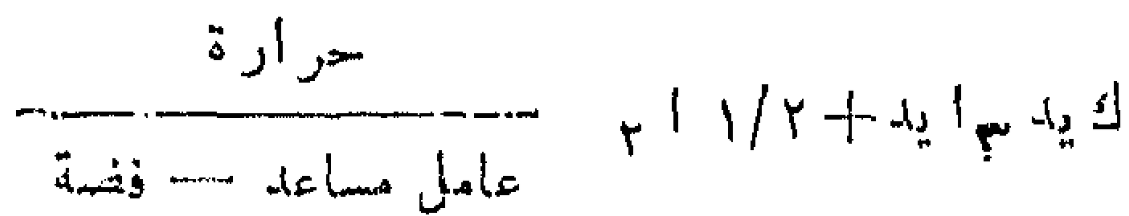
وتعرف في مجال الطب باسم الفورمالين (وهو في الحقيقة محلول مادة الفورمالدهيد في المـــاء بتركيز نحو ٣٧٫٥٪ بالوزن) ويتم تصنيعهـا غالبا بالطريقة التقليدية من الكحـول الميثيلي (الميثانول) الذي غالبا ما يحوي ثنائي ميثيل الأثير DME Dimethyl Ether بنسبـة ٢٪ بالوزن كناتج ثانوي في صناعة الميثانول .

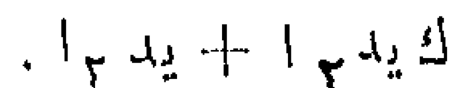
وهذا المنتج الثانوي سيكون أساس طريقة صناعة الفورمالدهيد بأقل التكاليف كماسيتضح فيما بعـد . ويمكن الحصوال على الفورمالدهيد بدرجة مركزة تصل الى ٩٩٪ وفي صورة صلبة وتعرف بمادة البارافورمالدهيد ، وتحل محـل الفورماليدهيد في مجالات استخـداماته ، مع توفير تكاليف النقل وسهولة التحكم في عمليات الانتاج بدرجة أفضل . وجدير بالذكر ان صناعة الفورمالدهيد توجت صـناعة البتروكيماويات حيث تتم صناعة الميثانول لهـذا الغرض ، من غازات البترول في مصانع البتروكيماويات .

صناعة الفورمالدهيد :

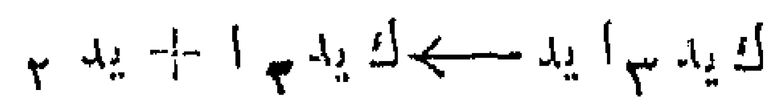
تتم صناعة الفورمالدهيد بالطريقة التقليدية بأكسدة الميثانول في وجود عامل مساعد وغالبـا ما يكون بلورات فضة عند درجة حرارة ٥٥٠ م° ويحدث التفاعل باحدى الصور الآتية :

ا — أكسدة المثانول على النحو التالي :





ب — ازالة الأيدروجين من الميثانول :



ويحتوي الميثانول عـلى نحو ٢٪ بالوزن من ثنائي ميثيل الأثير كنــاتج ثانوي خلال عمليـة تحضير الميثانول ولكن هذه النسبة تعطي كمية كبيرة ذات قيمة في حالة انتاج الميثانول على نطاق صناعي كبير ، وهو الذي يحدث حاليا .

ومع أن جـزء من هذا الـ DME يمـكن استخدامه في انتاج كيماويات مختلفة مثل ثنائي ميثيل السلفيد والايروزول ؛ الا انه يستـخدم للحريق أو طرده في الجو للتخلص منه .

ولكن توصل مكتب البحوث والتطوير بشركة أكيتا اليابانية للبتروكيماويات الى الاستفادة من هذا المنتج الثانوى لانتاج الفورمالدهيد منه بأقل تكاليف . وسيرد فيما بعد شرح لهذه الطريقة .

طريقة انتـــاج الفورمالدهيـد بأقل التكاليف (تصل الى نحو ٦٠٪ من تكاليف انتـــاجه من الميثانول) :

لقد بحثت شركة « هوكستر فارب » الالمانية انتاج الفورمالدهيد باكسدة ثنائى ميثيل الأيثير، كما بحثته شركة سوميتومو اليابانية للكيماويات واعتمدت كلا من الطريقتين على خلط الهـواء والأثير بنسبة تزيد بنحـو ١٨٪ من الايثير فى الخليط عن حد حدوث فرقعة هذا الخليط .

تم أكسدة هذا الخليط على سطح فضة أو نحاس كعامل مساعد . ولكنها تعطى انتاج ضئيل يعادل ١٠٪ فورمالدهيد فقط ، وقد تم استخدام عامل مساعد آخر هو خامس أكسـيد الفانديوم ولكن لم تزيد نسبة الانتـــاج عن ١٠٪ وهى ضئيلة .

الا أن مكتب البحوث والتطوير بشركة اكيتا اليابانية للبتروكيماويات ركز البحث عن عامل مساعد جديد لزيادة نسبة انتاج الفورمالدهيد من ال DM E وبعد بحث تأثير كثير من العوامل المساعدة لهذا الفرض ، فقد وجـــد أن ثالث أكسيد التنجستون هو بصـــفة خاصة أفضـــل عامل مساعد لهذا التفاعل .

فعند خلط أيثير مع الهواء بنسبة ٣ر٤٪ ، وهى اقل من حد حدوث فرقعة هذا الخليط .

تم تمرير هذا الخليط تحت ضغط عادى وعند ٤٥٠ ــ ٥٣٠ م° على ثالث أكسيد التنجستون ، فانه يمكن تحول الاثير الى فورمالدهيد بنسبة ٩٠ ــ ١٠٠٪ وكمنتجــــات ثانوية يخرج أول أكسيد الكربون وثانى أكسيد الكربون مع قليل من حامض الفورميك .

وبدراسة تحضير العامل المساعد صـــناعيا لهذه الطريقة ، أمكن الوصول الى أن كربيـــد السليكون أوثالث أكسيد الالومنيوم عند تغطية سطح أيهما بثالث أكسيد التنجستون المخلوط مع ١٠٪ حامض فوسفوريك فان النـــاتج يكون عامل مساعد لانتاج الفورمالدهيد بهذه الطريقة صناعيا .

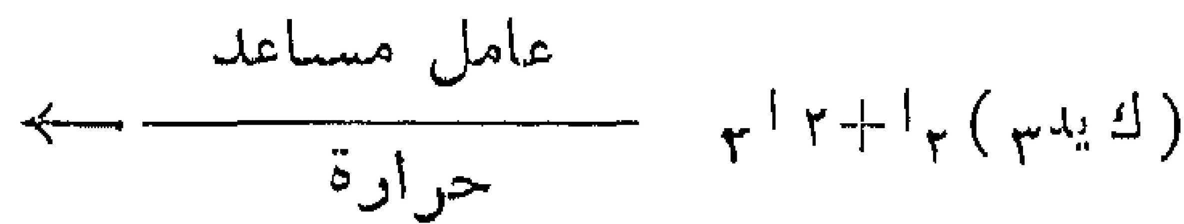
شرح الطريقة :

يوضح الرسم التالى طريقة سير العملية :

1) Reactor.
2) Quench box.
3) Primary absorber.
4) Secondary absorber.
5) Formic acid removal.
6) Formaldehyde product tank.
7) Start ap salt heater.

— Akita Petrochemicals uses this flow sheet for formaldehyde productuon from byproduct dimethyl ether.

ويتميز تفاعل انتاج الفورمالدهيد بأكسدة الأثير بأنه يعطى كمية وفيرة من الحـرارة كمـا توضح معادلة التفاعل الاتية :



٢ ك يد٣ ا + يد٢ ا + ١٨ كيلو سعر حرارى

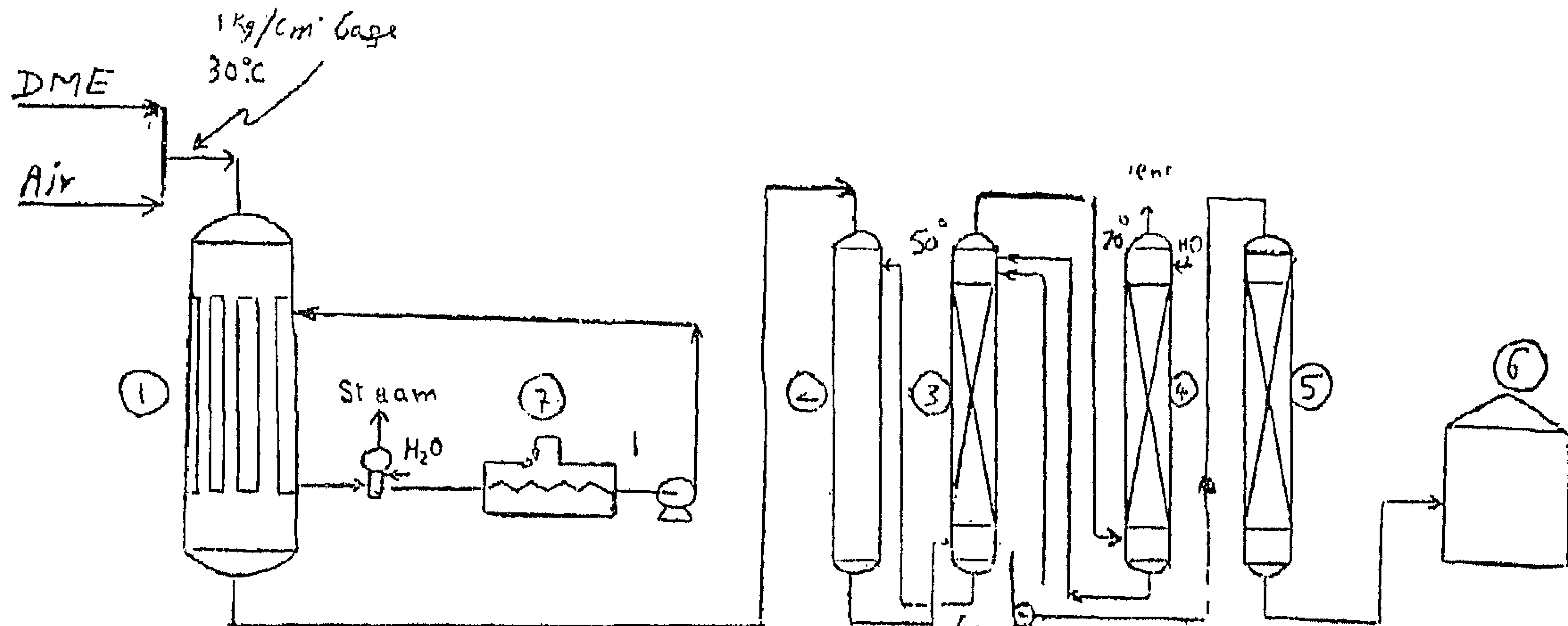
كما تحدث التفاعلات الجانبية الاتية لتعطى المنتجات الثانوية وتعطى أيضا حرارة كثيرة :



١٨١ كيلو سعر حرارى



+ ٣٦٠ كيلو سعر حرارى



الامر الذى يستوجب ضرورة تصميم مفاعل الأكسدة بطريقة تسمح بازالة الحرارة النـاتجة بصفة مستمرة وبدون توقف .

وكما يوضح الرسم ، يدخل خليط الهـواء والأثير فى الحالة الغازية الى المفاعل وهذا المفاعل يتكون من عديد من الأنابيب المحتوية على ثالث أكسـيد التنجستون ، ويمر مصـهور ملحى خارجها كأفضل وسط للتبريد لهذه العمليـة (وهذا المصهور الملحى يقوم بالتبريد بواسـطة نقل الحرارة الناتجة من التفاعل الى جهاز لتوليد البخار . فعند بدء العملية يتم صهره فى جهاز صهر خاص وينقل بواسطة طلمبة مغموسة فى ذات المصهور ، وبعـد ذلك يقف عمل جهاز الصهر وتستمر حالة الملح منصهرة بواسـطة الحرارة الناتجة من التفاعل ، ويبرد بواسطة جهاز لتوليد البخار ، يعمل على نفس دائرة سير مصهور الملح ليحفظ درجة حرارته ثابتـة . وجدير بالذكر ان البخار الناتج من هذه العملية تبلغ كميته ٦٠٠ كجم بخـار عنـد ضغط ٥ كجم/سم٢ لـكل طن محلول فورمالدهيـد ٣٧٪ بالوزن) ثم يبرد فجائيا الغاز الناتج من المفاعل بمحلول فورمالدهيـد قادم من أسفل جهاز الامتصاص الأول ويدخل الغاز بعد ذلك الى جهاز الامتصاص الأول . وهو عبارة عن برج يتم فيه استرجاع محلول الفورمالدهيد من برج الامتصـاص الثـانى ليمتص ما يمـكن من الفورمالدهيد من الغاز الناتج ثم يمر الغاز بعد ذلك الى جهاز الامتصاص الثانى . وهو عبارة عن برج اخر يتم فيه امتصاص كل الفورمالدهيد من الغاز بدخول ماء من أعلى البرج .

يمر بعد ذلك محلول الفورمالدهيد من جهاز الامتصاص الأول الى جهـاز ازالة حامض الفورميك . وبعد ذلك يمر محلول الفورمالدهيد الخالى من حامض الفورميك الى مستوع المنتج .

والملاحظ ان اولى مزايا انتاج الفورمالدهيد من ثنائى ميثيل الاثير هو الانخفاض الكبير فى تكاليف انتاجه .

وفيما يلى بيان كميات الخامات والخـدمات اللازمة لانتاج طن فورمالدهيـد ٣٧٪ تركيز بالوزن هى :

- ثنائى ميثيل الايثير ٣٧٩ر طن
- ميـاه تبريد ٣٠ر٠٠٠ طن
- بخار مسترجع من حفظ حرارة مصهور الملح ٦٠٠ر طن
- عامل مسـاعد (ثالث أكسيد التنجستون ٣٠٠ر كجم
- كهرباء ٨٤ كيلوات ساعة
- ميـاه نقية ٥٤٠ر طن
- ملح مصهور ٢٥٠ر كجم

وميزة ثانية لانتاج الفورمالدهيـد بهـذه الطريقة ، انه يمكن انتاج فورمالدهيد خال من الميثانول كأحد شوائبه ، وبذلك تنخفض تكاليف الانتاج أكثر حيث لا يلزم عمليـة تقطير لازالة الميثـانول الذى لم يتم تفاعله فى حالة انتـاج الفورمالدهيد من الميثانول .

وجدير بالذكر ان الفورمالدهيد الخال من الميثانول قد زاد عمليـة الطلب بغـرض انتـاج بولى فورمالدهيد فى مجال صناعات البلاستيك، ولا شك ان هذه الميزة سوف تظهر قيمتها أكثر فى المستقبل خاصة فى حالة توفر ثنائى ميثيل الاثير .

كما انه يمكن استخدام محلول اليوريا بدلا من المـاء فى جهاز الامتصاص الثانى لامتصاص الفورمالدهيد من الغازات الناتجة فى هـذه العملية ، الامر الذى تظهر أهميته فى صـناعة راتنج اليوريا فورمالدهيد بأقل تكاليف ايضا ، لانتاج الراتنج اللازم لصناعة الخشب الحبيبى أو لانتـاج بودرة كبس اليوريا فورمالدهيـد كخامة بلاستيك أساسية لعـديد من الأدوات المنزلية والصحية وايضا بعض الأدوات الصناعية

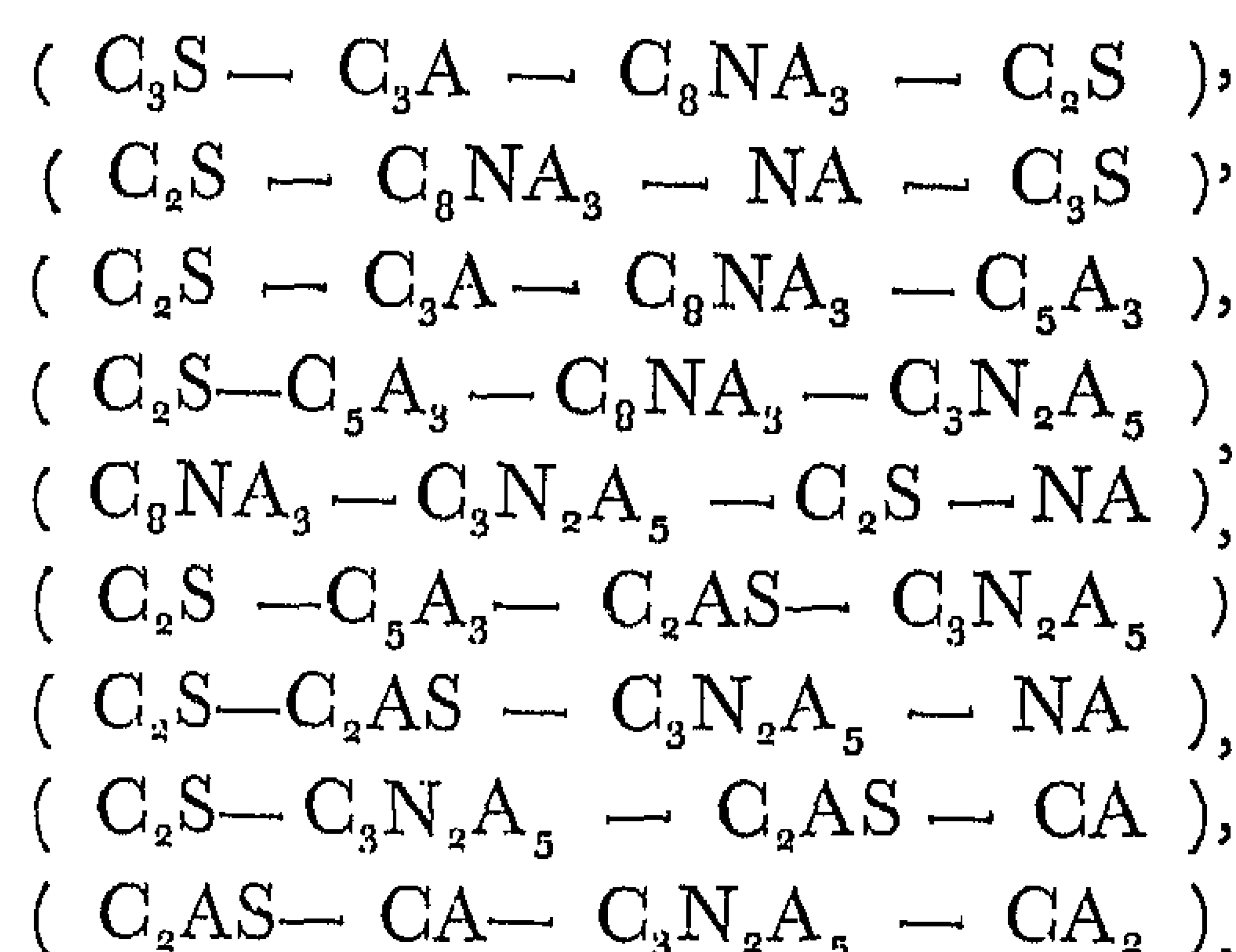
المرجع : Hydrocarbon proessing Nov. 1966
Vol. 45 - No. II.

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Conjugation triangles joining the above phases were drawn in the quaternary system. Also in view of the present results at 1150°C, a conjugation tetrahedron C_2S-C_2AS-NA-NAS_2 was added. It should be noted that conjugation triangles divided the quaternary to small tetrahedrons consuming the available volume.

Since it has been proved that at high temperatures, a ternary solid solution containing NA, NAS_2 and some SiO_2 as well as Na_2O is present, the compositions represented by stoichiometric points and noted NA & NAS_2 will not lie on the shown places and their correct positions depend on the temperature. This solid solution may also extend inside the quaternary forming a quaternary solid solution. This assumption is supported by Strokov, (2) who reported the existence of solubility of C_2S in NA. Also C_2S, which exists as a stoichiometric binary compound may extend in the quaternary. This is supported by Drojenen results mentioned earlier.

It is evident from the above discussion that mixtures calculated to lie on the line NA-C_2S do not belong to a binary system and the equilibrium phases present depend on the composition and temperadure used. If C_2S composition lies above the line C_2S-NA the following compatible phases may be met with during firing;



(C_3S — C_3A — C_8NA_3 — C_2S),
(C_2S — C_8NA_3 — NA — C_3S),
(C_2S — C_3A — C_8NA_3 — C_5A_3),
(C_2S — C_5A_3 — C_8NA_3 — $C_3N_2A_5$),
(C_8NA_3 — $C_3N_2A_5$ — C_2S — NA),
(C_2S — C_5A_3 — C_2AS — $C_3N_2A_5$)
(C_2S — C_2AS — $C_3N_2A_5$ — NA),
(C_2S — $C_3N_2A_5$ — C_2AS — CA),
(C_2AS — CA — $C_3N_2A_5$ — CA_2).

and (C_2S-C_2AS-NA-NAS_2). If C_2S composition lies below the line C_2S-NA other sets of compatible phases exist but since some of the above phases were met with during this work and previously published work. it could be concluded that if C_2S forms a quaternary solid solution its composition will be above the line NA-C_2S.

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(8) O. Abdel-Karim, A.M. Gadalla & S.Y. Ezz, "Effect of Firing Nepheline on Acidic Extraction of Alumina", To be published.

the rate can be changed by the angle of inclination as well as the number of r.p.m.

On heating the charge loses its moisture content followed by oxidation of free iron oxide to ferric form. As the charge moves towards higher temperatures, dissociation of $CaCO_3$ starts gradually from 350 to 840°C. Below 800°C, CaO reacts with silicates present in minor amounts such as aegirine and aegirine-augite. From 840°C, nepheline starts reacting with CaO forming dicalcium silicate and deacreasing the stability of $CaCO_3$. At first no NA is formed since it is expected to react with feldspars forming nepheline rich solid solution. Active lime attacks this solid solution, leaving it poorer in silica with its composition approaching NA, thus the amount of feldspars decreases. This effect may be pronounced at 890°C.

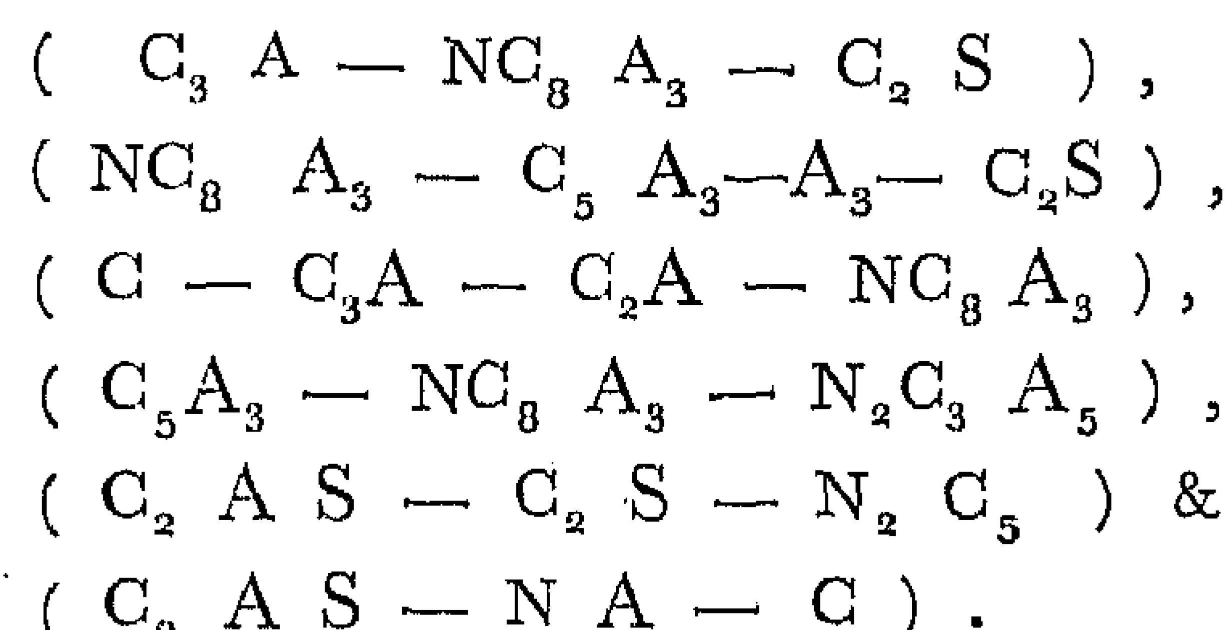
During heating, various feldspars dissolve in each other and the higher the temperature the higher is the solubility limit. On reaching 1030-1170°C partial melting of the charge occurs due to melting of feldspars solid solution. The liquid phase formed increases the contact area between solid particles, thus increasing the reaction rate. Further heating increases the solubility of solids in liquid phase. The latter on cooling precipitates C_2 S & NA and other phases depending on the composition of the charge and the temperature of firing as will be shown later.

It should be noted that using nepheline ore from Gabal El-Nigrub El-Fogani requires firing below 1250°C and for a short period to avoid complete vitrification or formation of excessive crusts in the kiln.

4.2. THE SYSTEM C_2 S-NA:

It was evident from phases obtained after firing for 45 hrs. at 800°C or for 36 hrs. at 900°C that equilibrium was not attained. But the equilibrium phases present at 1150°C were C_2 AS, C_2 S, NA-rich solid solution and NAS_2 -rich solid solution. Phases precipitated from liquid formed at 1250°C were C_2 S, NA & C_2 AS. It is apparent that C_2 S & NA which were the aim of firing, do not constitute a binary system since such system should contain a maximum of three condensed phases. To understand the reason for the presence of such several phases, a quaternary system N-C-A-S was constructed as shown in Figure 3. In this quaternary the known binary and ternary compounds as well as the conjugation triangles existing in the systems; N-A-S, N-C-S-, N-C-A & C-A-S(2) were plotted ignoring solid solutions for simplicity.

Greene & Bogue(2) investigated three sections in this quaternary and in view of their esults it can be deduced that no quaternary compound exists. This conclusion is in contradiction to that of Khazanov et. al.(5); that NAC_2 S exists at high temperatures and dissociates to NA & C_2 S at lower temperatures. It seems


(C_3 A — NC_8 A_3 — C_2 S) ,
(NC_8 A_3 — C_5 A_3—A_3— C_2S) ,
(C — C_3A — C_2A — NC_8 A_3) ,
(C_5A_3 — NC_8 A_3 — N_2C_3 A_5) ,
(C_2 A S — C_2 S — N_2 C_5) &
(C_2 A S — N A — C) .

that they based their conclusion on the presence of X-ray lines not belonging to either C_2 S or NA as mentioned earlier.

It could be concluded from Greene & Bogue's sections that the following groups of compatible phases exist:

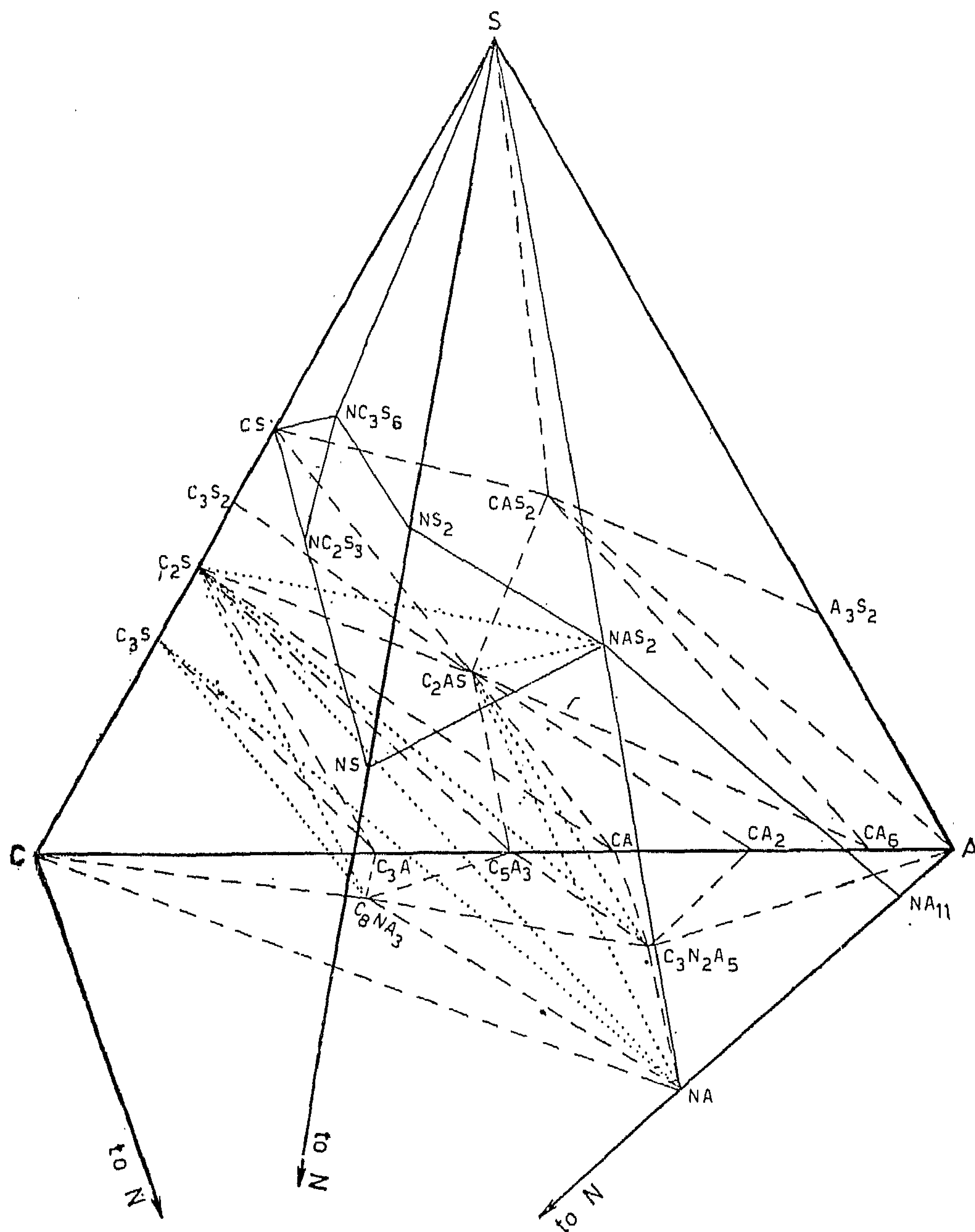


Fig. (3) : Symplified quaternary system $Na_2O - CaO - Al_2O_3 - SiO_2$.

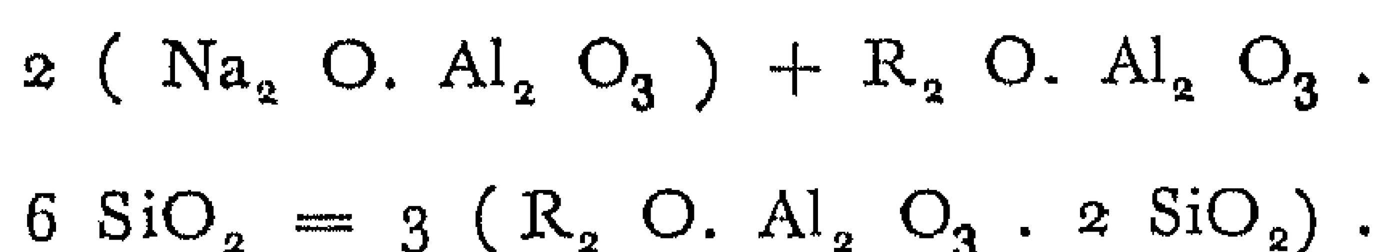
4. CONCLUSIONS

4.1. MECHANISM OF FIRING CORRECTED NEPHELINE ORES :

From the above results it could be concluded that on heating corrected nepheline ore in the rotary kiln, the following mechanism is suggested. It should be noted that the temperstures reported here were based on using fine powders (-150 mesh) and heating rate of 10°/min. While coarser particles and higher rates are expected to shift these temperatures to higher values, lower rates will shift them to lower values. As mentioned earlier, for a rotary kiln of definite length,

res above 1125 C. Its presence at 900°C implies that CS can exist as a nonstoichiometric compound forming solid solution which lowers the transition point below 900°C and the formed α CS was preserved due to the high cooling rate.

Heating for 17hrs. did not show appreciable attack (on) feldspars by CaO. This attack was pronounced after heating for 36 hrs, at which their relative amounts decreased. Prolonged heating increased also the formed calcium silicates. It is thus expected to find a compensating amount of NA. Its absence may be explained in view of the system Na_2O-Al_2O_3-SiO_2 shown in Fig. 1. It is obvious that NA is not compatible with feldspars, thus the latter will react with the formed active NA according to the equation :



$$2\,(Na_2O.\,Al_2O_3) + R_2O.\,Al_2O_3\,.\,6\,SiO_2 = 3\,(R_2O.\,Al_2O_3\,.\,2\,SiO_2)\,.$$

Since lines of all forms of nepheline were absent from the first hour of heating, it could be concluded that the produced NAS_2 was attacked by free lime forming calcium silicates. Thus the SiO_2 content of nepheline decreased and its composition moved towards composition of NA. Accordingly, the unknown lines of the X-ray patterns mentioned earlier could be considered to correspond to one of the members of the solid slution series between NAS_2 & NA and data on this solid solution was not found in the literature. It should be noted that the existence of various calcium silicates proves that equilibrium was not reached.

In view of the above results it could be concluded that the endothermic reaction enhancing dissociation of $CaCO_3$ occurring from 870-950°C (Figure 2), is due to the formation of C_2S as a result of the reaction of $CaCO_3$ with nepheline. Also the exothermic peak obtained at 980°C may represent reaction between feldspars and NA solid solution.

3.2.4. Soaking At 1150°C:

Specimens were fired at 1150°C for 1, 2 & 4 hours. The calculated d-spacings indicate that phases present in all specimens were the same. These were β C_2S, C_2AS. NA-rich solid solution and NAS_2-rich solid solution (the presence of the latter two phases will be discussed later).

Since heating for one hour was enough for all starting minerals to disappear and further heating did not change the phases produced, equilibrium was attained in less than one hour. The rapid achievement of equilibrium was due to the relatively high temperature and due to the liquid phase formed from feldspars. While pure albite melts at 1118°C (See Figure 1), potash feldspar melts peritectically at 1150° giving KAS_4 (leucite) and liquid silicate. Solid solution between albite and potash feldspar decreases the above temperature to about 1080°C (See the system $KAlSi_3O_8$-$NaAlSi_3O_8$).(2) As soon as melting occurred it was expected that reaction with lime should take place.

The presence of NA in equilibrium with NAS_2 solid solution suggests the existence of a miscibility gap in this solid solution series.

3.2.5. Soakng At 1250°C:

Specimens were fired at 1250°C for 1,2 & 4 hours. After one hour the initial phases disappeared giving C_2S, C_2AS & NA. After 2 or 4 hrs, only C_2S & NA were present. It should be mentioned that firing for 4 hrs formed a homogeneous liquid and although the specimen was air quenched devitrification to C_2S & NA occurred. C_2AS produced after an hour is expected to dissolve in the liquid phase by further heating.

3.2. PHASE CHANGES ON SOAKING:

3.2.1. Soaking At 200°C:

Firing at 200°C did not produce phase changes detected by x-ray. This implies that the exothermic reaction occurring from room temperature to 260°C (Fig. 2) is encountered with minor constituents beyond the accuracy of the X-ray diffractometer. This reaction is probably due to oxidation of iron ores to haematite. This suggestion is supported by Abdel Karim et. al.(8) observation that the ore was changed to reddish colour.

3.2.2. Soaking At 800°C:

At 800°C soaking was carried out for 1,24 & 45 hrs. After an hour partial decomposition of $CaCO_3$ occurred giving CaO which formed the hydrate after cooling to room temperature. Heating for 24 hrs showed that while traces of $CaCO_3$ were present, β-C_2 S was formed and nepheline, microcline and albite were also present. Prolonged heating for 45 hrs showed the presence of albite microcline, C_2 S & C_3 S. While nepheline disappeared d-spacings 4.33, 3.57. 2.88, 2.69 & 2.67 could not be referred to any compound in the ASTM cards. According to the phase diagram published by Tuttle & Smith(2), in presence of potassium, nepheline transforms to high nepheline at a temperatuse. depending on the amount of K+, above 880°C. Unfortunately, values for d-spacings for the latter compound were not published, and so it was assumed that the unknown lines of the x-ray pattern obtained after firing for 45 hrs correspond to this compound. The fact that nepheline exists as solid solution (See Fig. 1), explains the reason for its transformation at a temperature lower than that reported. Accordingly it can be concluded that dissociation of $CaCO_3$ took place slowly and even firing for 24 hrs was not enough for complete dissociation. The CaO produced had a high hydration tendency and after cooling gave $Ca(OH)_2$. Nepheline, albite and microcline were not attacked by CaO and only solubilities of microcline in albite and vice versa caused a change in their relative amounts as noticed from variation in relative intensities. Corresponding shift in d-spacings was not detected since their values were very near. Also it can be concluded that C_2 S was formed by reaction of free lime with other silicates such as aegirine-augite. This may explain the endothermic peak observed to overlap with that of dissociation of $CaCO_3$ giving a break at about 800°C (See Figure 2).

Firing for 24 hrs produced a little amount of C_2 S which increased by further heating and reacted with free CaO giving C_3 S. Although the samples were air quenched, the rate of cooling was not high enough to preserveβ C_2 S, which was found to be partially transformed to γ C_2S. This transformation occurs at 725°C as indicated by the phase diagram CaO-SiO_2 (2).

3.2.3. Soaking at 900°C:

Firing was carried out at 900°C for 1, 17and 36 hours. After an hourβ C_2 S was detected, $CaCO_3$ decreased and all lines of nepheline disappeared giving lines which are referred to NAS_2 -NA solid solution (See later). After 17 hrs., albite. microcline and the latter solid solution decreased, β & γ C_2 S, α CS as well as traces of C_3S & C_3S_2 were formed. After 36 hrs., microcline disappeared and amounts of albite and solid solution decreased. Other phases formed after 17 hrs were also present.

It can be concluded that after one hour, $CaCO_3$was partially dissociated forming CaO which attacked the minor silicate constituent (as discussed earlier) as well as nepheline formingβ C_2 S. On further heating other calcium silicates were formed. These were C_3 S. C_3S_2 & α CS. The binary system CaO-SiO_2 (2) shows that α CS is formed at temperatu-

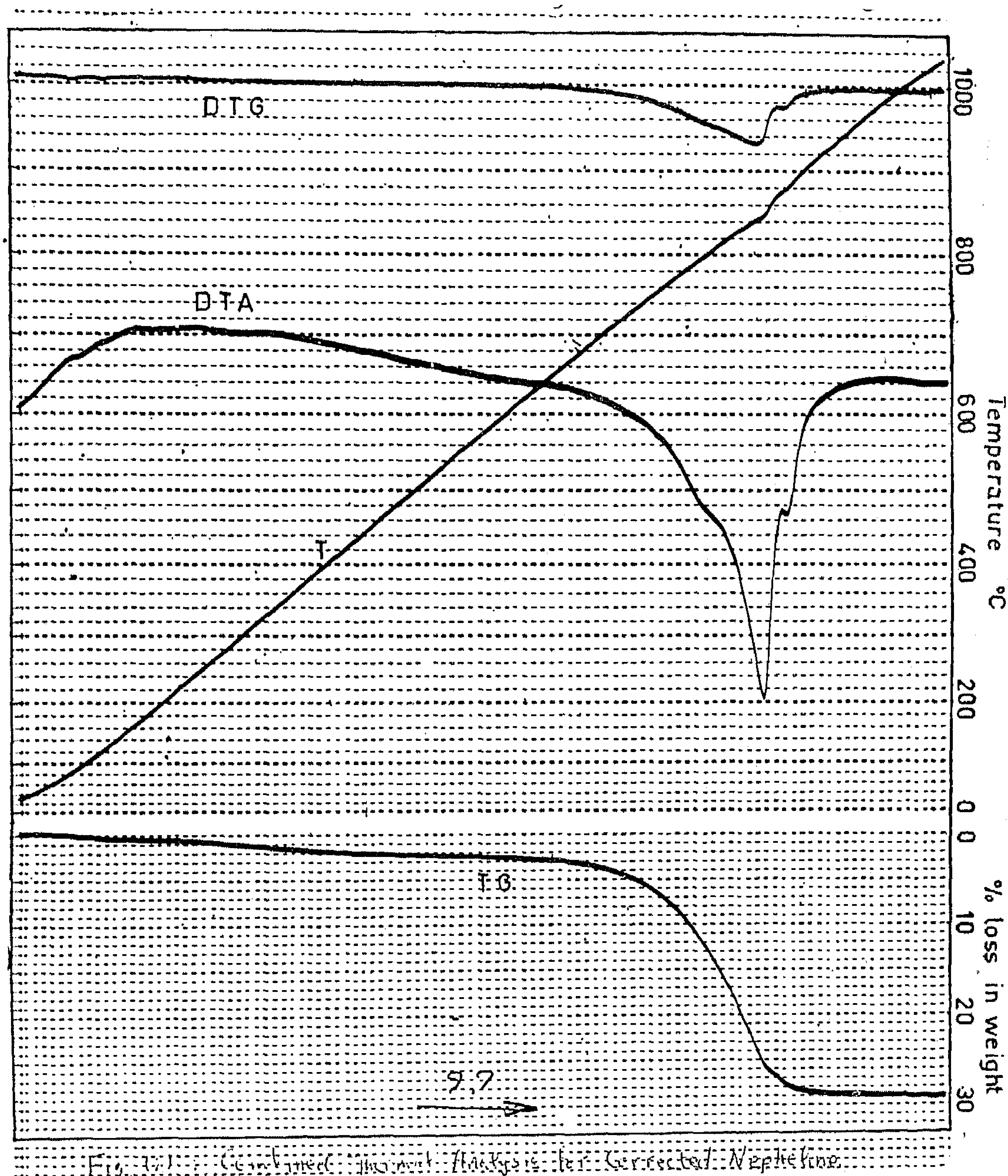


Fig. 2 — Combined thermal anulys is for Corrected Nepheline

It should be noted that Belesky et. al. (2) found another endothermic reaction at 1030-1170°C on doing DTA curve which they have not explained.

Explaining the above reactions will be discussed after studying the effect of soaking at 200, 800. 900, 1150 & 1250°C. These temperatures were selected aiming to throw light on the equilibrium phases at each temperature and the kinetics to reach equilibrium.



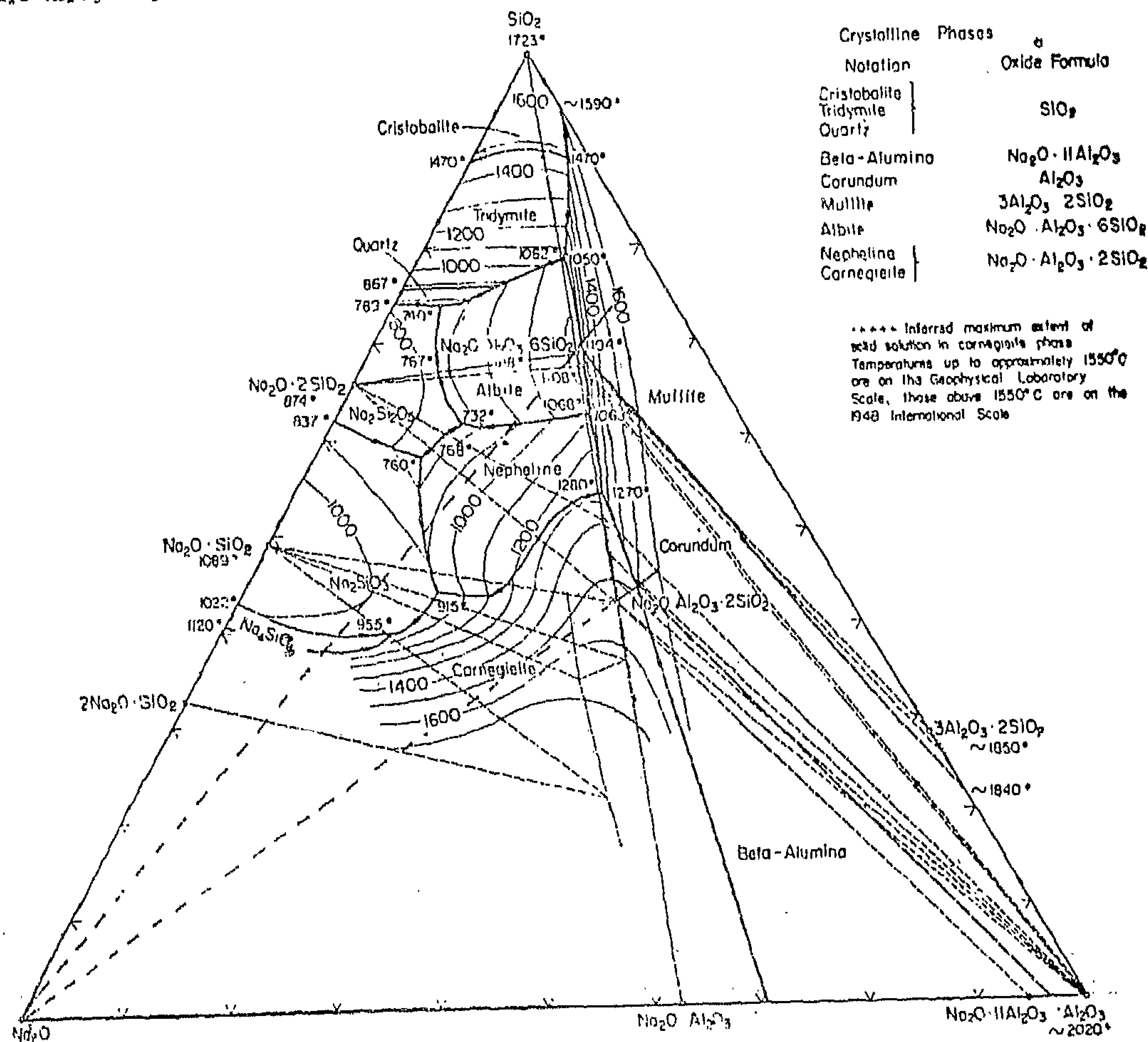


FIG.(1): THE SYSTEM $Na_2O - Al_2O_3 - SiO_2$.

Obtaining such curves simultaneously, for the same material heated at the same rate, is very useful, since it enables one to recognize whether an energy change is associated with or without weight change. Points of starting and ending of the various reactions can thus be sharply defined.

From Figure 2 it can be concluded that from room temperature up to about 260°C, a slight loss in weight of about 1% occured. This was accompanied by an exothermic reaction. From 350 to 950°C a loss in weight (about 28%) corresponding to the CO_2 evolved due to the dissociation of $CaCO_3$ (See TG curve). occurred and was accompanied by a large endothermic peak at 840°C followed by a small one at 880°C. The knee observed on the DTA curve at about 800°C implies the presence of two overlapping endothermic peaks. Since the TG curve does not show a corresponding break, it could be concluded that the first peak corresponds to a reaction not accompanied by weight change, while the second peak represents the dissociation of carbonate, as mentioned earlier. From 870 to 950°C another endothermic reaction took place, during which dissociation of carbonate also occurred. With further heating, a slight exothermic reaction occurred at 980°C without weight change.

C_2S and AN were formed by prolonged heating, but also other compounds such as; Calcium silicate, calcium aluminate, and gehlenite (C_2AS).(2) Using X-ray Shaaban, Gadalla & Ezz(4) proved the existence of anorthite (CAS_2), gehlenite and $N_2C_2A_3$ besides C_2S & NA after firing for 24 hrs at 1000°C. On firing at 1200°C for 10 hrs they obtained $\beta\ C_2S$, $\gamma\ C_2S$, and NA and after firing at 1300°C for 3 hrs little amount of NA was noticed with the glassy phase. By cooling high temperature phases, they proved that the reactions occurring in this system are reversible.

2.2. THE MECHANISM OF THE FIRING PROCESS :

Accodring to Strokov(2) the charge loses its moisture content, then some reactions occur with a slight shrinkage and formation of a little amount of liquid. This is followed by excessive shrinkage and formation of a porous clinker. Using high temperature X-ray diffraction, Khazanov et. al.(5) did not notice any reaction to occur from 650-800°C except the dissociation of limestone. They stated that the reaction with nepheline took place at 950°C in three steps:

$NAS_2 + 2C = C_2S + NAS$ and at higher temperatures NAS forms a quaternary unstable compound (NAC_2S) after reacting with lime. This compound was considered to dissociate at low temperatures giving NA & C_2S.

It should be noted that they have not mentioned reactions with feldspars and that NAS does not exist in the ternary system Na_2O-Al_2O_3-SiO_2 shown in Figure 1.

Dumskia(6) stated that high iron content acted as a flux and decreased the percentage of alumina extraced. This behaviour was clear when the alkali content was not enough to compensate for the iron present (to form alkali ferrite).

If the amount of CaO is higher than required, C_3S & / or calcium aluminates are formed. Free lime is undesirable since it reacts with alumina forming insoluble hydrated calcium aluminate. If lime is not enough, other compounds may form and decrease extraction of alumina.



$$NAS_2 + C = CAS_2 + N$$

If the alkali content is not enough the following reaction was suggested(2) thus decreasing the alumina to be extracted.



$$A + C_2S = C_2AS$$

3. RESULTS AND DISCUSSIONS

The firing process of corrected nepheline was studied on ore from Gabal El-Nigrub El-Fogani which consisted mainly of nepheline, microcline, albite and aegirine-augite and contains; 58.4% SiO_2 19.4% Al_2O_3, 4.4% Fe_2O_3 & 13.4% ($Na_2O + K_2O$).

3.1. FIRING CORRECTED NEPHELINE WITH A RATE OF 10°/MIN.:

Rate of heating nepheline in the rotary kiln can be varied by changing the length and the angle of inclination. In this study a rate of 10°/min was selected and correction of the charge was made by adding calculated amounts of analytical grade $CaCO_3$ & Na_2CO_3. These were thoroughly mixed with — 150 mesh ore, which was examined in a derivatograph, in which combined differential thermal and thermogravimetric analysis were followed simultaneously. The curve indicated T in Figure 2, shows the change in temperature which can be read from the scale to the right. TG shows changes in weight and DTG indicates the rate of weight change. On any curve the temperature could be read by drawing through it a vertical line to cut the curve Tat a point corresponding to the temperature could be read by drawing through it a vertical line to cut the curve T ata point corresponding to the temperature indicated to the right.

MECHANISM OF FIRING CORRECTED NEPHELINE OREAND THE SYSTEM CA_2 SIO_4NA A 10

By

A.E. GAMI*, Dr. A.M. GADALLA & PROF. Dr. S.Y. EZZ*****

ABSTRACT

Equilibrium and kinetic studies were carried out on the corrected nepheline ore. Phase changes were followed by examining heat of reactions, weight changes and X-ray examination. A mechanism for the reactions occurring in the rotary kiln was proposed. In view of the present as well as previous results, it was concluded that the system: $Ca_2 SiO_4$-$NaAlO_2$ is not a true binary and the compositons considered to form this system are represented by a straight line crossing the quaternary system: Na_2O-CaO-Al_2O_3-SiO_2. The possible compatible phases were also deduced.

1. INTRODUCTION

Industrially alumina is produced from nepheline by adding limestone and soda ash (if necessary), so that there is one gram mole of sodium oxide to every gram mole of alumina and ferric oxide, and two moles of Calcium oxide to each mole of silica. The mixture is then fired in a rotary kiln up to 1200-1350 C.(1,2) This process is much more complicated and is accompanied with the formation of other phases depending on the composition of the charge, heating and cooling rates as well as time and temperature of firing.

In this paper, the mechanism of firing corrected nepheline will be investigated as as well as the equibrium phases present at various temperatures and their relation to the system $Ca_2 SiO_4$ - $NaAlO_2$. Abreviations used in cement technology were adopted here; N = Na_2O, K = K_2O, C = GO, A = Al_2O_3 & S = SiO·

2. PREVIOUS WORK

2.1. THE SYSTEM C_2 S-NA:

Since it was aimed to obtain dicalcium silicate (C_2 S) and soldium aluminate (NA), and although working with ores deals with multicomponent systems, as a first approximation, the system can be considered a binary system C_2 S-NA. This is not far from reality since the amounts of Fe_2O_3, MgO & TiO_2 are usually present in minor amounts which can be hardly detected by X-ray, which was used here for phase identification.

Toporove(2 and Greene & Bogue(3) claimed that these compounds form simple eutectic at 1405 + 10°C with composition of 39% NA and 61% C_2 S. Other research workers stated the presence of solid solutions. While Drojenen considered the solid solution to be of NA in C_2 S Strokove considered it to be of $\beta C_2S_{in}NA_2$ The latter stated NA can take 30% β C_2.S in solid solution. Drojenen claimed that the solubility of NA in C_2 S decreased by soaking at 1200-1250 C.

It has been proved that the situation is much more complicated and not only

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classify the different inhibitors to suit various conditions. Such classification is shown in Table III. It can be seen from this table that Cronox 653, kontol K 157 and Dodigen 481 are the most efficient at low and high temperatures, in acidic and alkaline media for C-steel as well as Monel.

Further it can be seen that kontol CL 23 and Sebecore S.C. are efficient for use at ambient temp. (pH 9) for C-steel. Dodigen 213, Magna 6687 and Magna 6688 are suitable for C-steel and Monel at pH 4 (S″ and Cl—).

These twelve commercial inhibitors were used for treating the corrosion problems in pipe lines and distillation towers for Suez Oil Petroleum Company.

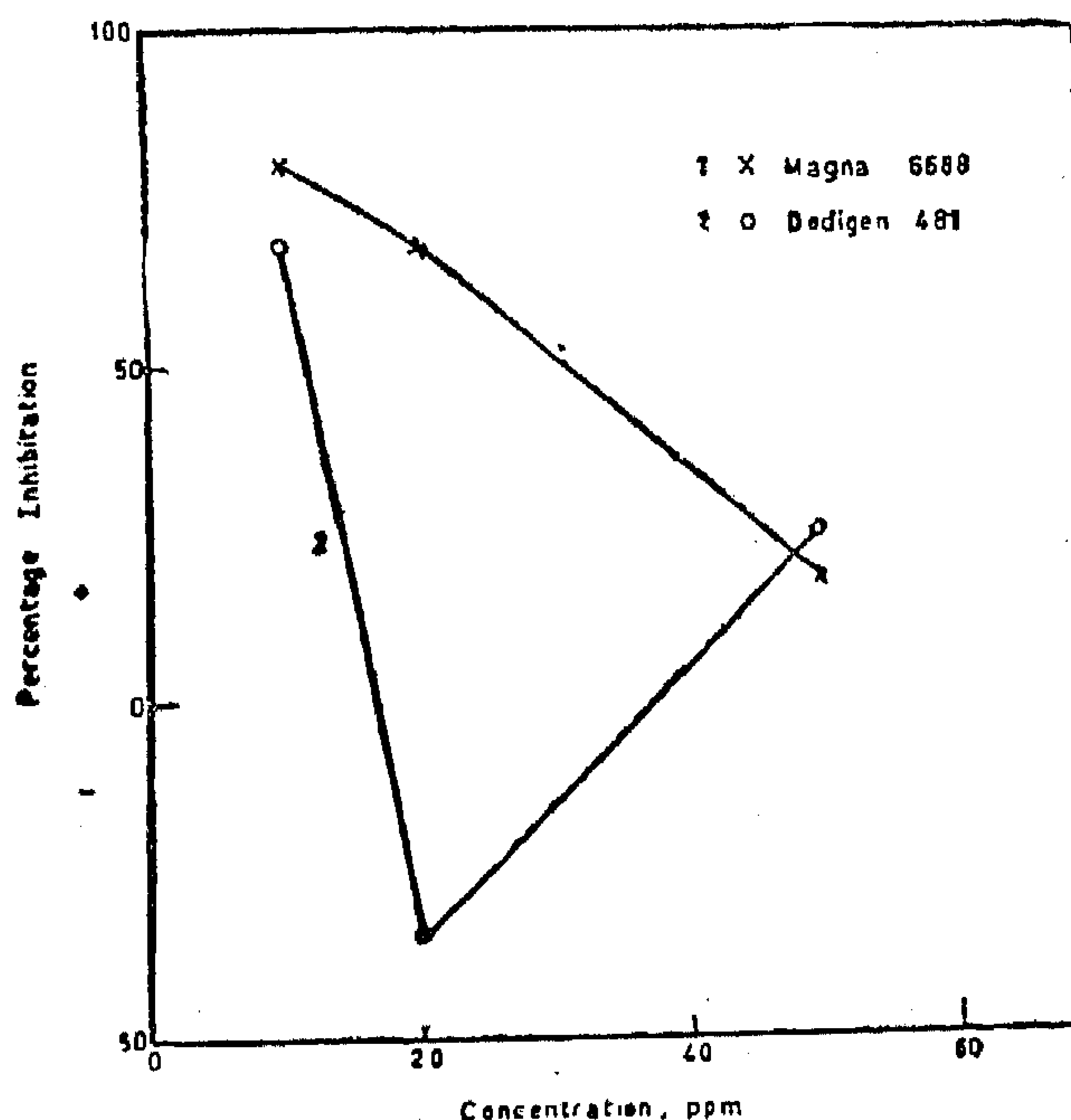


Fig 7 Inhibition concentration vs. percentage inhibition curves for Monel at 100°C.

Table III
Data Pertaining to the Most Efficient Inhibitors

Condition	Inhibitors					
	Cronox		Kontol K-157		Dodigen 481	
	Max. inh.	Dose ppm	Max. inh.	Dose ppm	Max. inh.	Dose ppm
1) Ambient temp. pH 9,Cl—, Steel	96 %	20	80%	20	80%	20
2) 100°C pH 12 S=, Cl—, Steel	81.8	7	91	133	72.7	17
3) 100°C, pH 4 S=, Cl—, monel	90	7	75	117	68	4

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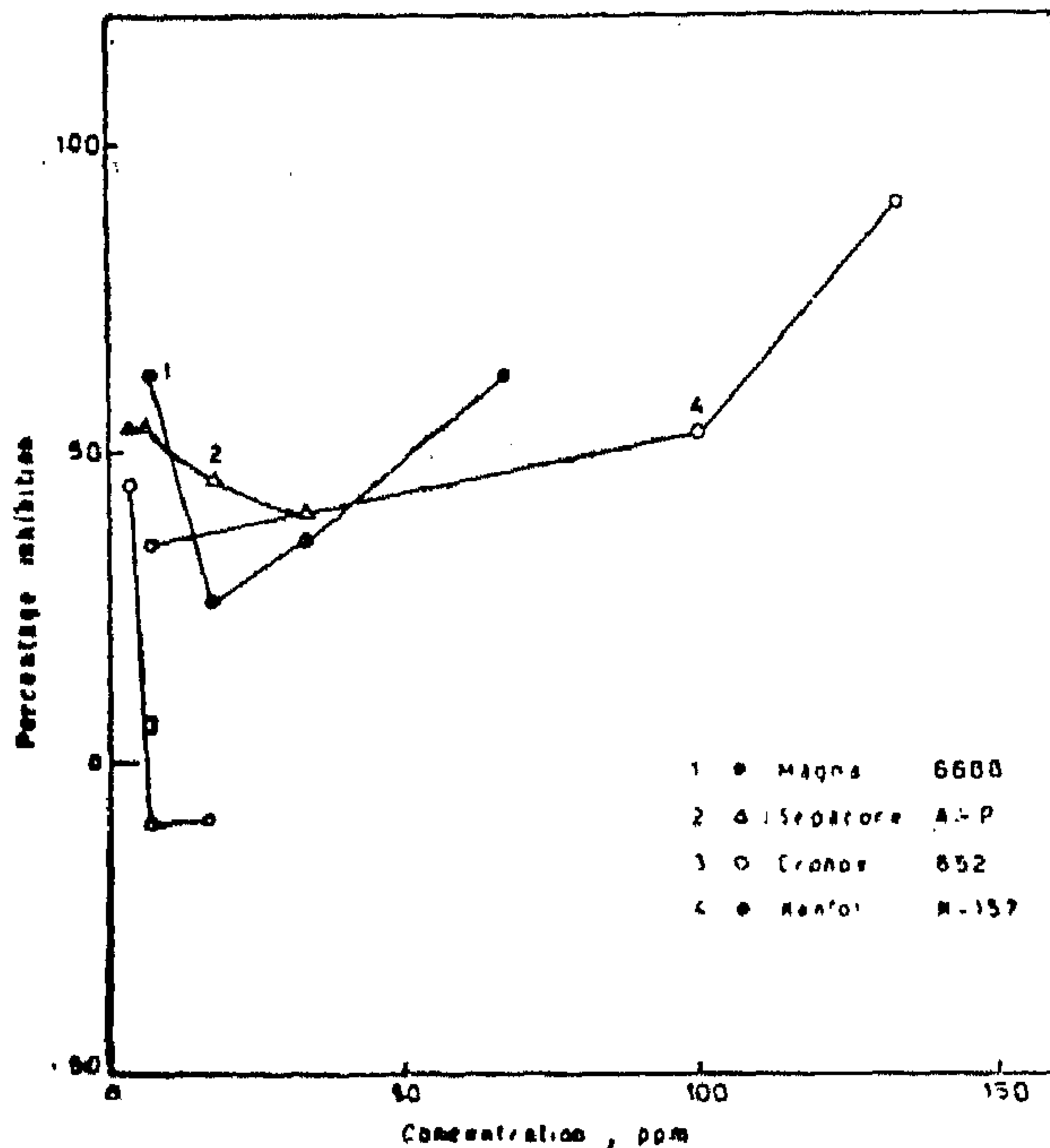


Fig 4 Inhibitor concentration vs percentage inhibition curves for C-steel at 100 °C

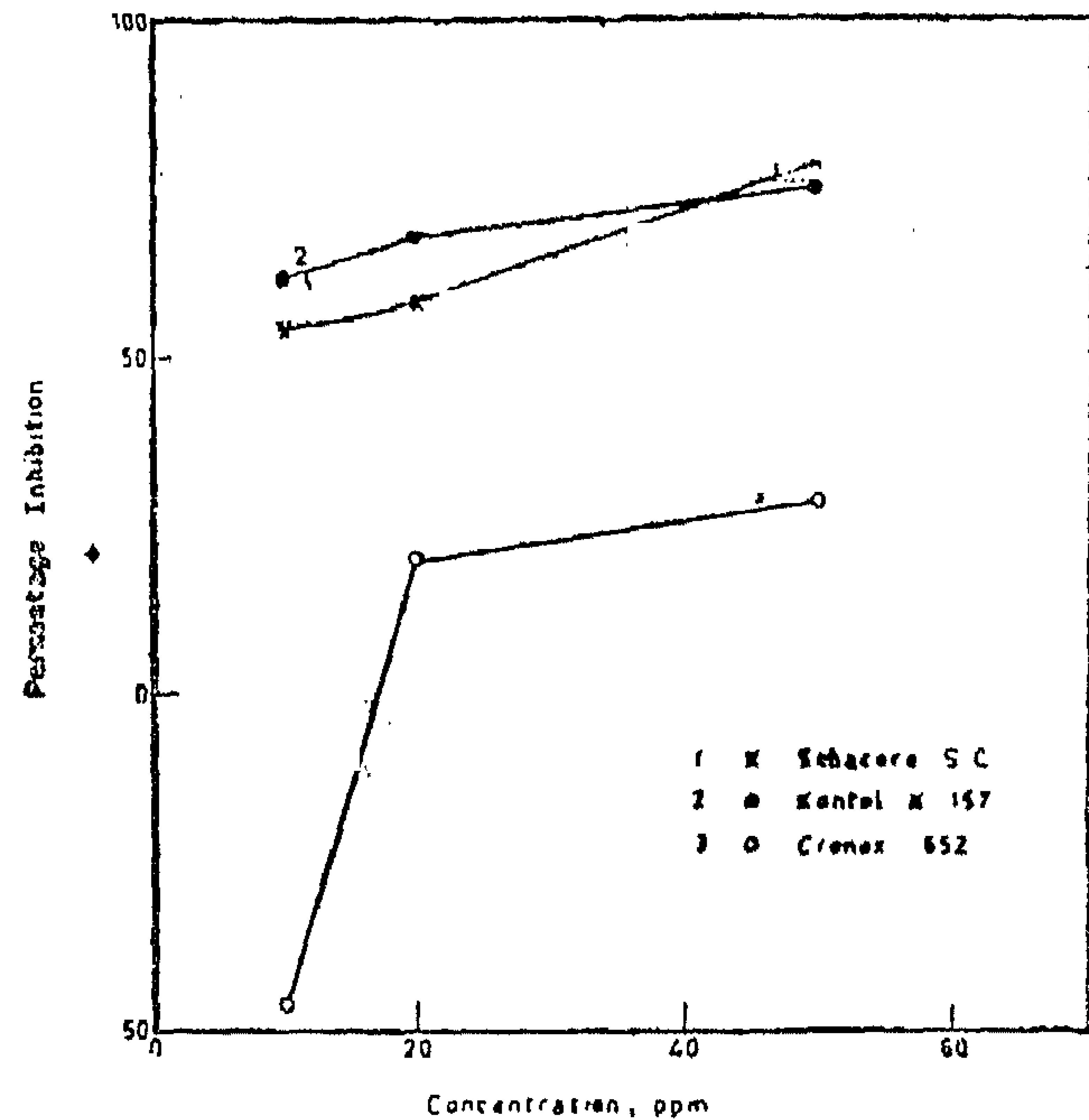


Fig 6 Inhibitor concentration vs. percentage inhibition curves for Monel at 100 °C.

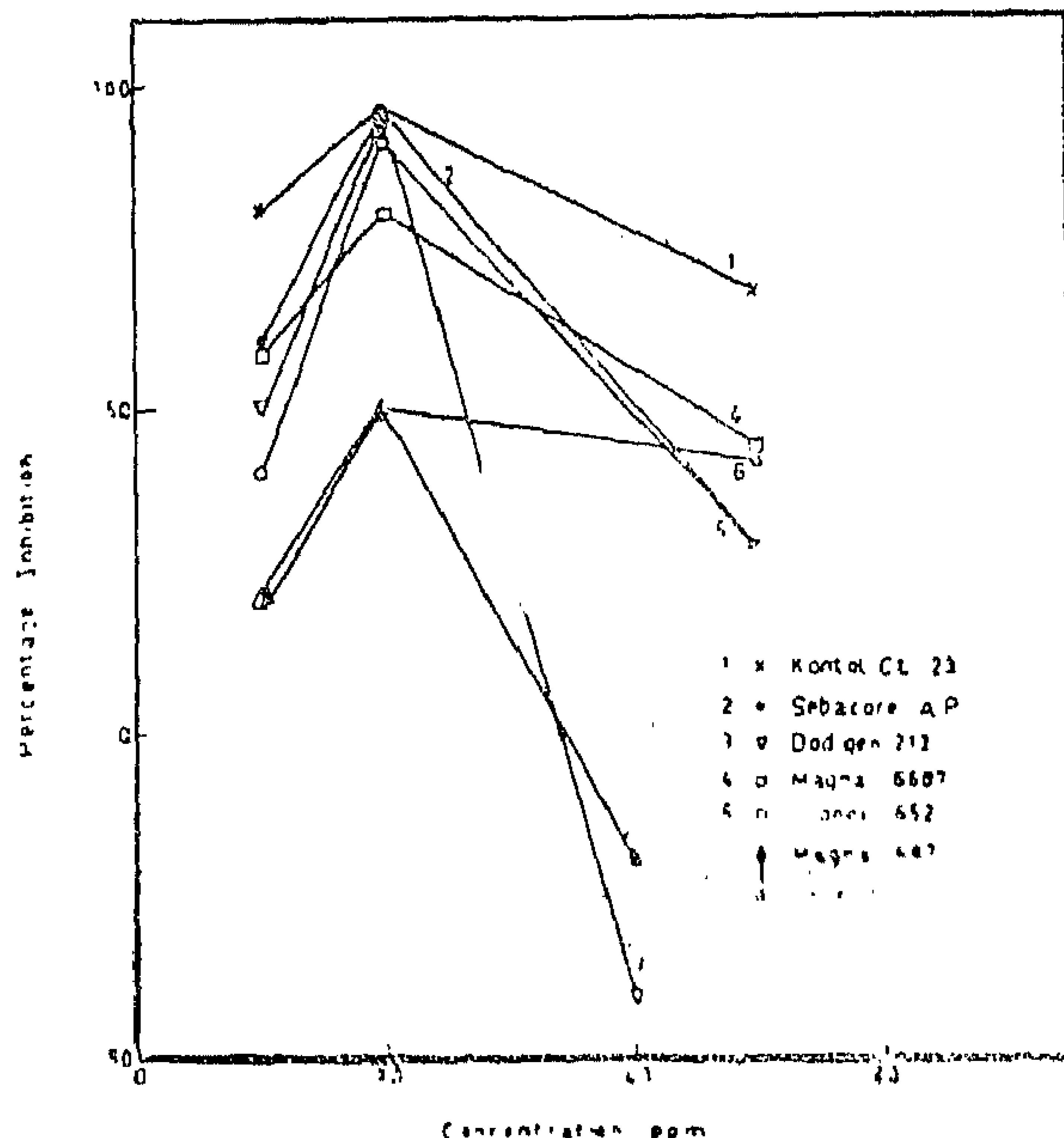


Fig 5 Inhibitor concentration vs percentage inhibition curves for Monel at 100 °C

b — **Monel**

Priminary work on monel at pH 12 showed that no corrosion at all could be traced. The experiments were carried out only at pH 4 where corrosion was detected. Three patterns of curve - inhibitor efficiency may be recognised. The first type of curves Fig. 5 reveals a maximum at 20 p.pm. The second type is represented by curves 1, 2 and 3 in Fig. 6. Curves 1, 2 and 3 obtained for sebacore S.C., kontol K — 157 and Cronox 652 where the afficiency rises sharply with increase in concentration. The third type is represented by curve 1 and 2 (Fig. 7) for Magna 6688 and Dodigen 481. The efficiency (in curve 1) decreases with increasing the inhibitor concentration, while curve 2 display a minimum at 20 ppm.

CONCLUSIONS

Consideration of the data presented in a previous (10) work carried out at 120°C and room temperature for C-steel as well as that of the present study allows us to

the inhibition increases sharply and reaches a value of 91 % at 133 p.p.m. Maximum inhibition and the corresponding inhibitor concentration obtained from Fig. 2 — 4 are shown in Table 1.

From the above results, the inhibitors may be classified into four categories according to the maximum inhibition affected by each. These comprise effeciencies $\geq$ 90, $\geq$ 70 $\geq$ 50 and $\geq$ 40 % inhibition as illustrated by Table II.

The increase in the inhibition efficiency with increasing the inhibitor concentration is due to an increase in the area covered by the adsorbed molecules.

Table II
Classification of the inhibitors according to their maximum inhibition for C-steel in boiling isopropyl alcohol (pH 12)

% Inhibition	Inhibitor name	per total solution (P.P.M.)
$\geq$ 90	Kontol K — 157	133
$\geq$ 70	Cronox 653	7
	Dodigen 213	7
	Dodigen 481	17
	Magna 6687	17
	Corexit	67
$\geq$ 50	Magna 6688	7
	Kontol CL 23	33
	Sebacore A.P	3
$\geq$ 40	Sebacore S.C.	17
	Cronox 652	3
	Magna 687	25

However, the decrease of the inhibition efficiency with the further increase of the inhibitor concentration after reaching a maximum value, may be ascribed to competitive adsorption between the inhibitor and the other species present in solution namely: S″, Cl— ions and water molecules. There is a possibility of competitive adsorption between the solvent and the solute at certain concentration range of the latter(9). The obtained isotherm represent therefore a composite relationship reflecting the competitive adsorption of the various species in solution. Apparently, beyond the maximum, the inhibitor becomes less adsorbed and is replaced by other species and therefore becomes less inhibition. It is worthnoting that acceleration of corrosion was only obtained at high temperature. This result is in harmony with that represented by Couper(8) where he found that at a temperature of 120°C inhibitors can cause corrosion.

3 it could be seen that the corrosion inhibition afforded by inhibitors 1 8 (cf. table 1) reaches a maximum value at a certain concentration whereupon it decreases by further increase in concentration. Figure 3, however, shows that the corrosion is enhanced if the concentration of the inhibitor (Sebacore S.C., Kontol CL 23, Magna 687 and Magna 6687) is lower than a certain value.

The curves obtained for Magna 6688, Sebacore A.P., Cronox 652 and Kontol K — 157 (Fig. 4) show that the behaviour in presence of these inhibitors is different from one inhibitor to the other and from that already described for the other 8 inhibitors.

Regarding the Magna 6688, Sebacore A.P. and Kontol K — 157 (curves 1 — 3 in Fig. 4) the percentage inhibition decreases with increase of inhibitor concentration. Curve 1, shows a minimum in the inhibition, curve 4 shows a regular increase in inhibition with increase of concentration up to 100 p.p.m. Whereupon

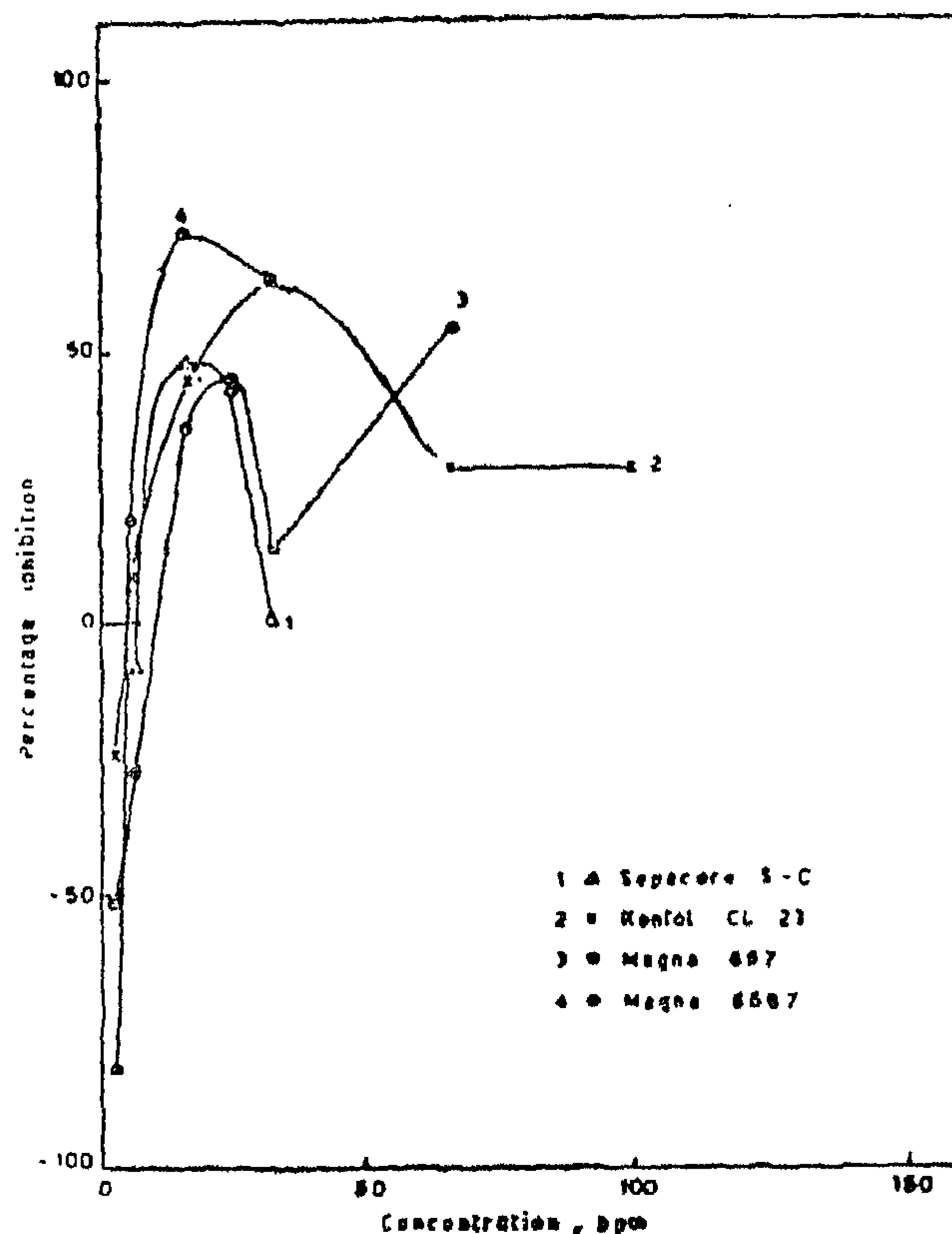


Fig 3 Inhibitor concentration vs percentage inhibition curves for C-steel at 100°C

Table 1

Maximum inhibition for C-Steel in isopropyl alcohol (pH 12) at 100°C

NO	% Inhibition (Max)	Inhibitors name	Concn. of inhibitor per total soln. (p.p.m.)
1	72.72	Corexit	67
2	81.81	Cronox 653	7
3	72.72	Dodigen 213	7
4	72.72	Dodigen 481	17
5	63.33	Magna 6688	7
6	54.24	Sebacore A.P	3
7	90.99	Kontol K. 157	133
8	48.15	Cronox 652	3
9	48.50	Sebacore S.C	17
10	63.33	Kontol CL. 23	33
11	45.45	Magna 687	25
12	72.72	Magna 6687	17

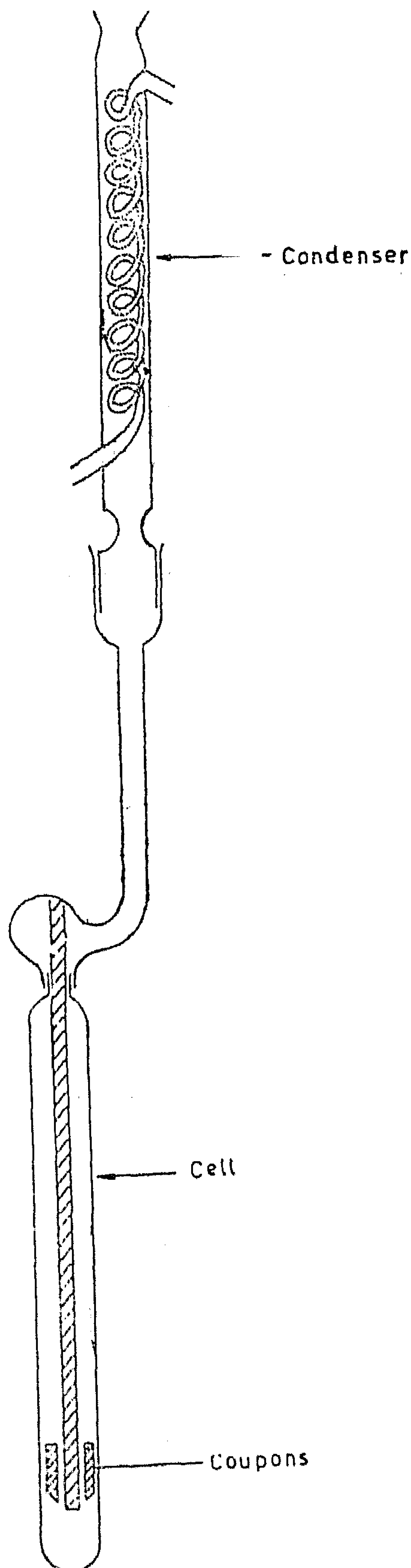


Fig. 1. Apparatus used in the isopropyl method

moles Na S and 0.01 moles NH_4 Cl with 60 ml of isopropyl alcohol containing the desired concentration of the inhibitor.

Coupons having the dimensions 1 x 5 x.02 cm were cut from C-steel sheets. Each coupon had a hole at its upper part for hanging in the reaction vessel. Prior to each experiment the coupons were ground by emery papers 400 and 600, cleaned with benzene and finally weighed. The reaction vessel containing these solutions was placed in a boiling water bath. When the mixture was brought to boiling, 3 steel coupons were weighed and immersed in solution mixture for 3 hours. The steel samples were then removed from the reaction vessel and the corrosion products were stripped by immersion for 10 min. in solution containing 1 g/1 thiourea dissolved in 10 % H_2SO_4.

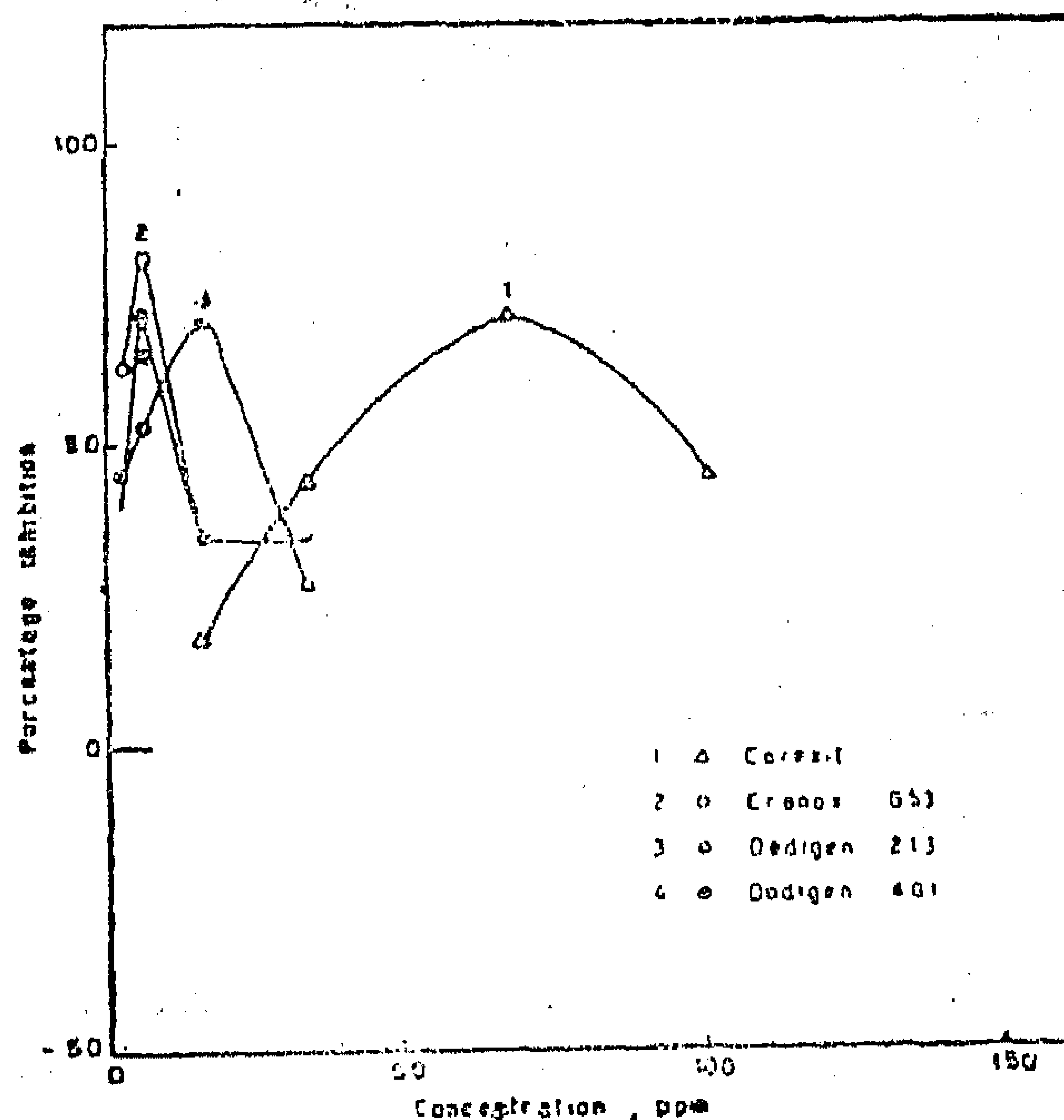


Fig 2 Inhibitor concentration vs percentage inhibition curves for C-steel at 100 °C.

RESULTS

CORROSION INHIBITION

a — C-Steel

Figures 2 — show the relationship between the percentage inhibition and concentration of inhibitors in boiling solution for the 12 inhibitors. From Figs. 2 and

CORROSION INHIBITION OF STEEL AND MONEL BY SOME INHIBITORS USED IN PETROLEUM REFINERIES

By

K.M. EL-SOBKI, A.A. ISMAIL and S.H. SANAD

ABSTRACT

Twelve commercial inhibitors used in petroleum refineries have been tested for the corrosion inhibition of C — steel and Monel at 100°C. The relationship between the inhibitor concentration and % inhibition was determined for each inhibitor.

For Monel, in acid media, it was found that all inhibitors with the exception of Cronox 652 reduced the corrosion rate by 50-96%. The optimum dose varied between 7-17 p.pm. Based on the maximum inhibition efficiency, the inhibitors are arranged in order of decreasing inhibition efficiency as follows : Sebacore A.P. $\searrow$ Kontol Cl 23 $\searrow$ Dadigen 213 $\searrow$ Cronox 653 $\searrow$ Magna 6687 $\searrow$ Sebacore S.C. $\searrow$ Kontol K. 157 $\searrow$ Dodigen 481 $\searrow$ Magna 6688 $\searrow$ Corexit $\searrow$ Magna 687 $\searrow$ Gronox 652.

The corrosion inhibition of C — steel, in alkaline media, was tested. According to their behaviour the inhibitors are classified into 4 categories in relation to their maximum inhibition. These comprises efficiencies $\geq$ 90 $\geq$ 70 $\geq$ 50 and 40 %.

INTRODUCTION

Corrosion of condensers and associated equipments by overhead stream from crude oil distillation towers is a major problem in petroleum refineries. The corrosion occurs at moderate temperature where water is condensed or inorganic salts are deposited on the presence of acide generated from the decomposition of impurities in the crude oil. Control of this corrosion becomes more critical as larger units are built which must be kept onstream continuously for larger times (1,2).

Crude oils received at the refinery generally are free of H_2S. However, they contain organic sulfur compounds that decompose in hot furnaces to give H_2S which, along with the HCl, comes out the top of the distillation tower into the condenser system. Water from the crude oil or added as steam during the distillation also is present in the condensers.

When the water condenses in the presence of HCl, H_2S and possibly some volatile organic acids, a strongly acidic solution is produced which is highly corrosive particularly to C-steel (3-7). Many units have exchanger parts of admiralty metal, aluminium brass, cupronickel, or monel to better resist corrosion (8).

The aim of the present work is to evaluate the corrosion inhibition of both monel and C-steel by using commercial inhibitors.

EXPERIMENTAL

To avoid the problem of immiscibility of gazoline with the aqueous aggressive medium at 100°C, it was thought of using other inhibitor solvents which should be miscible with the aqueous aggressive solutions and at the same time do not have any aggressive action towards steels. Isopropyl alcohol was found to fulfil these two points. The reaction vessel used is shown in Fig. 1. The solution was prepared by mixing 120 ml containing 0.128

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